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Waihou and Piako ecological monitoring 2017



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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.

In this survey, several sites in both the Piako and Waihou catchments had substantially lower numbers of fish, particularly bullies, in 2017 than in previous years. It is likely that these declines were the result of temporary displacement of fish following heavy rains and high flows which occurred in the middle of our sampling period. The sites in both catchments which were sampled prior to the rain had the highest numbers of fish, and the relative abundances of species were comparable to previous years, supporting this conjecture.

The presence of galaxiids was variable, consistent with past surveys. Banded kokopu were found at two sites and inanga at one site, for two of the sites it was the first record for the species since monitoring began. However, galaxiids were also absent from other sites at which they had been found in past years. This suggests that these species are likely present in most sites in very low numbers, and thus are captured some years, but not others.

Exotic species were also present at multiple sites. Brown and/or rainbow trout were present at four of the five Waihou sites, and mosquitofish were captured in one.

Macroinvertebrate community index scores declined at most sites compared to the previous year, but remained within the range of variability observed over the entire monitoring period. Again, it is possible the change in scores reflects temporary displacement of individuals associated with the heavy rain and high flows immediately prior to sampling. The percentage of sensitive (EPT) individuals also declined at the majority of sites, although EPT richness and total richness was higher at most sites compared to 2016.

Habitat quality scores improved at several sites in both Waihou and Piako catchments, largely in association with increased riparian cover and bank stability and reduced sedimentation and periphyton cover. The few sites with decreased scores were primarily due to increased bank instability, likely the result of greater livestock access than in previous years. Periphyton and macrophyte cover were generally comparable to that observed in previous years, although slightly lower at some sites due to the scouring associated with recent rain events.

It is recommended that annual ecological monitoring continues at these ten sites. The year-toyear variation observed over the course of the survey indicates the importance of determining the natural inter-annual variability of native fish and macroinvertebrate populations to provide a more robust baseline against which to monitor the effects of human impacts on these river ecosystems. For example, next year's survey should help us determine whether some of the results observed this year were temporary impacts resulting from higher-than-usual flows at this time of year, 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 2014), 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 2014). 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, Croker et al. 2011; Franklin and Bartels 2012; Franklin, Smith et al. 2013; Franklin, Croker et al. 2014; Graham, Franklin et al. 2015; Graham, Franklin 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, Smith 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 in late February 2017 (Table 2-1 & Figure 2-1). The sites were those sampled in 2014, 2015, and 2016 following the recommendations of Franklin, Smith et al. (2013). 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 2014-2017 ecological monitoring sites in the Waihou and Piako catchments.
Easting and N	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
5	Piako	Piakonui Stream	1831220	5809988	100	160
6	Waihou	Paiakarahi Stream	1841027	5867879	34	60
7	Waihou	Karengorengo Stream	1848393	5823235	100	30
8	Waihou	Wairere Stream	1851649	5819801	108	40
9	Waihou	Waiteariki Stream	1852566	5818150	112	97
10	Waihou	Waitawheta River	1845480	5849662	71	177

2.2 Flow

Mean daily flow (m³/s) 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. Although a period of heavy rain occurred during the annual monitoring period in mid-February, flows remained well below bedmoving values, therefore a two-week stand-down period was not required. However, sampling was postponed for several days until conditions were once again safe for electric-fishing.

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. 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.

Three representative bullies were collected from each site at which they were present for genetic analysis to resolve past concerns regarding the true identification (common vs. Cran's) of the bullies at the sites, given the relative distance inland and size range of some of the bullies captured. Each bully was stored in 100% ethanol and sent to the Cawthron Institute, where a mitochondrial gene (cytochrome b) was sequenced for phylogenetic analysis.

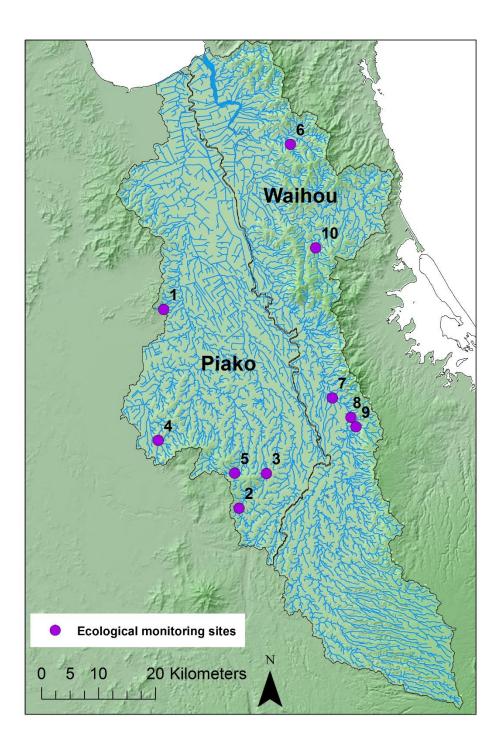


Figure 2-1:Location of the 10 ecological survey sites sampled in the Waihou and Piako catchments during2014 – 2016.Site numbers refer to those listed in Table 2-1.

2.4 Macroinvertebrates

Macroinvertebrate sampling was carried out following the standardised procedures for wadeable streams as outlined by WRC (Collier and Kelly 2005). In soft-bottomed streams, woody debris, macrophytes and stream banks were sampled, as appropriate, using a hand net (0.5 mm mesh) following MfE Protocol C2 (Stark, Boothroyd et al. 2001). For hard-bottomed streams, a kick-sampling approach targeting riffle areas and following MfE Protocol C1 was utilised (Stark, Boothroyd 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, Boothroyd et al. 2001). This provides proportional abundance data suitable for the calculation of most invertebrate parameters (Collier and Kelly 2005). Complete taxonomic lists were compiled and a range of community metrics calculated at the taxa level indicated in Collier,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, Hamer 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, Hamer et al. (2014)¹. The percentage cover of different submerged and emergent species of macrophytes was also recorded, allowing calculation of the macrophyte cover indices (Collier, Hamer et al. 2014).

¹ In the course of calculating the PEI using the updated formula from Collier et al. (2014) we noticed that, because it requires dividing only by the number of transects in which periphyton were present, sites that had periphyton in one transect had higher overall enrichment scores than sites with periphyton across multiple transects, which seems counterintuitive. However, comparison of scores calculated using the new and old methods on the same data showed a 0.95 correlation, suggesting that this may have been an issue in the past calculations as well.

3 Results

3.1 Piako catchment

3.1.1 Flow

Mean daily flows were low and stable for the first half of the year preceding sampling. As expected, higher flows occurred over the autumn and winter months, with two periods of high flow, in June to July and September to October. This pattern is consistent with flow patterns in most previous years (Figure 3-1). However, in 2017, a medium-sized rain event occurred earlier than usual, during the annual monitoring period in mid-February (Figure 3-1).

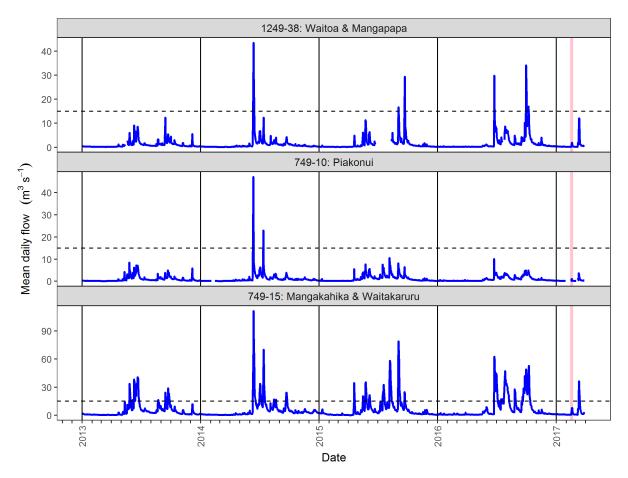


Figure 3-1: Mean daily flow (m³ s⁻¹) in the Piako catchment between 2013 and 2017. Each flow monitoring site is listed first, followed by the survey sites for which it is the closest reference. Tick marks indicate months, the year label is located on the January tick mark. The 2017 sampling period is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

3.1.2 Fish

Six of the eight native fish species found across the five survey sites in the Piako catchment during the 2014-2016 surveys were captured in 2017 (Table 3-1). The two species not present were koaro (*Galaxias brevipinnis*), which were captured in Piakonui Stream in 2016, and torrentfish (*Cheimarrichthys fosteri*), which were captured in Waitakaruru Stream in 2014 and 2015. Shortfin

(Anguilla australis) and longfin (Anguilla dieffenbachii) eels were both present at all five sites. This was an increase in distribution of longfin eels, which were only captured at three sites in 2016. Koura (Paranephrops planifrons), the freshwater crayfish, were also found at all five sites, as in previous years. Freshwater shrimp (Paratya curvirostris) were not observed at any site, although they had been present in Waitoa Stream in 2016. Bullies were not captured in Piakonui Stream in 2017, whereas in the past bullies were present at all five sites. Phylogenetic analysis of the three fish collected per site was unable to resolve whether the bullies present were common (Gobiomorphus cotidianus) or Cran's (Gobiomorphus basalis), therefore in this report all bullies will be referred to as C. bully, pending further investigation. Banded kokopu (Galaxias fasciatus) were captured in the Mangakahika Stream, similar to previous years, but not in Piakonui Stream, where they have been present in past years. However, banded kokopu were captured for the first time in Mangapapa Stream. Torrentfish were not captured in any of the Piako streams in 2017, including the Waitakaruru, where they were present in 2014 and 2015. Inanga (Galaxias maculatus) were found in Mangakahika Stream for the first time since sampling began, although they were not captured in Mangapapa Stream, where they had been present in 2016, potentially indicating that inanga are rare in these streams, and it is likely that their populations are too small to be sampled consistently yearto-year. No exotic species were captured, even though they are known to be locally abundant in some areas of the Piako catchment.

Mangakahika Stream had the greatest diversity of fish species of the five Piako catchment sites, with five native fish species and koura. The abundance of shortfin and longfin eels in Mangakahika Stream in 2017 was similar to those recorded in previous years. The abundance of bullies, on the other hand, was slightly lower than 2016, but substantially higher than other years. Banded kokopu were captured in greater numbers than in 2016, but were still lower in abundance than in 2015 and 2014.

In Waitoa Stream, abundances of all fish species were lower in 2017 than in 2016. The largest change was in the number of bullies; only 8 were caught in 2017, compared to over 300 in 2016. The majority of the 300 captured in 2016 were young of the year; there were approximately 1.5 times as many fish in size classes 20-40 mm than in all the other size classes combined. The low numbers of bullies in 2017 could suggest either poor survival or out-migration of fish at this site during the year. There were also only around one third the number of shortfin eels in 2017 that there were in 2016.

There were approximately three times as many shortfin eels captured in Mangapapa Stream in 2017 than in 2016, but only a quarter the number of bullies. The two patterns could be linked, as eels prey upon bullies, however prior to this year there had been an increasing trend in the abundance of both species in this site, suggesting bottom-up rather than top-down control of the food web. Longfin eel abundances were similar to those observed in previous years. A banded kokopu was captured for the first time in this site.

Shortfin and longfin eel abundances in the Waitakaruru were the highest reported since 2014, but the abundance of bullies was the lowest yet observed at this site. Again, the decline in bullies could be due to greater predation by an increasing eel population. Alternatively, the low abundances of bullies in all sites but Mangakahika Stream could be associated with the heavy rain and high water levels which occurred the week before these sites were sampled (Mangakahika was the only Piako catchment site sampled prior to the rain). For example, bullies move into the shallower margins during and following floods (Jowett and Richardson 1994) or burrow into the substrate, where they are more difficult to capture via electric-fishing. Interestingly, however, torrentfish, which prefer higher velocities, were not found in the Waitakaruru in 2017 or 2016, although they were present in 2015 and 2014.

In Piakonui Stream, the abundance of shortfin eels in 2017 was the highest yet recorded, and no bullies were captured for the first time since sampling began in 2014. The lack of bullies but increase in eels suggests that the low numbers of bullies across the catchment is likely a temporary condition associated with higher flows, as otherwise there should also be fewer eels due to a decline in food resources. The galaxiids koaro and banded kokopu were also absent from Piakonui Stream in 2017, although they were captured in either the previous year (koaro) or all previous surveys (banded kokopu).

Ordinations based on dissimilarity between community matrices can be used to study assemblage composition, or relative balance of different species, over time. In an ordination plot, communities which are more similar are plotted closer together and those that are less similar are further apart. An ordination of the fish assemblages for each survey year shows that the Piako communities are more similar within streams than between streams (i.e., the sampling dates for each stream cluster closely together; Figure 3-3). However, for all sites except Mangakahika Stream the fish community composition in 2017 was substantially different (further apart in ordination space) from the preceding years. This likely reflects the much lower abundances of bullies in four sites (excluding Mangakahika Stream) in 2017 compared to other years. Shortfin eels were also less abundant in Waitoa and Waitakaruru Streams than in previous years, but more abundant in Mangapapa and Piakonui Streams. The lower abundances observed in 2017 could have been associated with the heavy rain and increased flow that occurred the week before these sites were sampled, which may have displaced some species, although the flows were not high enough to be considered "bed-moving," the discharge above which effects on fish and invertebrates are predicted and a two-week sampling stand-down period is required (WRC personal communication).

Fish length data provide information on fish recruitment and survival rates. Size distributions of shortfin eels at the Piako catchment sites in each survey year are shown in Figure 3-4 and size distributions of bullies are shown in Figure 3-5. 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 bullies are given in Table 3-2.

The size distribution of shortfin eels was right-skewed in most sites in 2017, due to high proportions of small eels with a few large or very large eels. The size distribution of shortfin eels within a site has remained fairly consistent between 2014 and 2017 (Figure 3-4). The one exception in 2017 was the Mangapapa Stream, which had many more small eels (<200 mm in length) than in previous years. However, a similar pattern of high numbers of small eels has been observed in Piakonui and Waitoa Streams across all years. Furthermore, in Piakonui Stream the number of small eels in 2017 was the highest yet observed, and the number of large eels (400-800 mm) the lowest. There were fewer large (400-800 mm in length) and very large (>800 mm in length) eels captured at all sites in 2017 than in 2016 (Figure 3-4). The scarcity of large eels at these sites is consistent with known habitat constraints such as a lack of large pools. Additionally, the downstream migration of adult male eels, which typically migrate at between 350-500 mm in length (Todd 1980), intraspecific competition, and commercial or traditional harvest pressure may also be contributing factors to low numbers of large eels at these sites.

Longfin eels were only present in low numbers at all sites and the majority of those captured were >300 mm in length. Compared to the shortfin eel populations in the Piako, the smaller size classes appear to be significantly under-represented in the longfin eel population (Table 3-2). The lack of juvenile longfin eels may relate to either poor recruitment of this species, or be an artefact of the

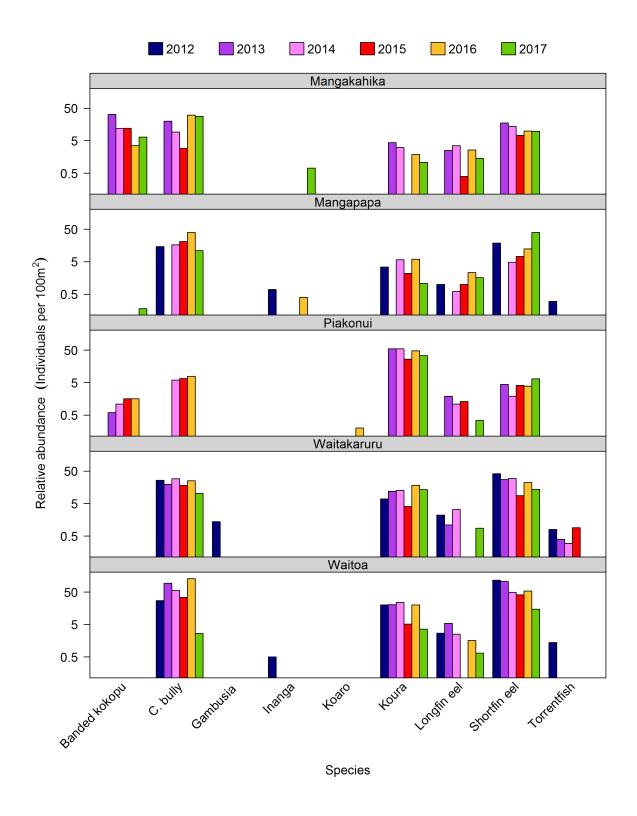
limited sampling, as longfin elvers tend to stay closer to the coast for longer compared to shortfins (B. David, personal communication).

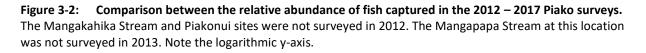
The size distribution of bullies has been variable across years at most sites (Figure 3-5). Bully size distributions tend to be approximately normal (i.e., greatest number of median-sized fish) or right-skewed (small fish most abundant). However, bimodal distributions can also occur, indicating peak densities of multiple size classes, such as in Waitoa Stream.

In 2017, Waitakaruru Stream had an approximately normal distribution, while the size distribution in Mangapapa Stream was right-skewed, with more small bullies (<30 mm in length) than larger bullies. There were very few small bullies in Mangakahika Stream, on the other hand, resulting in a more left-skewed distribution. Waitoa Stream had few bullies overall, but those captured were large adults (50-80 mm) (Figure 3-5). At some sites, such as Mangapapa Stream, the size distribution remained fairly consistent over time, with the same size class most abundant each year. At several of the other sites, however, the size class which is most abundant varied between years (Figure 3-5). Additionally, Waitoa Stream had a bimodal distribution, indicating the presence of multiple cohorts.

Site	Year		ortfin el		el		entified eel	C. I	oully	Torre	entfish	Ina	inga		nded kopu	Ко	aro	Ко	ura
		Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA
1. 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	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
	2014	120	49.1	6	2.5	-	-	135	55.2	-	-	-	-	-	-	-	-	59	24.1
3. Mangapapa	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. 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
	2014	89	29.7	10	3.3	-	-	88	29.3	1	0.3	-	-	-	-	-	-	38	12.7
5. Piakonui	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

 Table 3-1:
 Results of 2014-2017 electric fishing surveys at the five Piako catchment monitoring sites. A = Number caught (abundance); RA = Relative abundance (individuals per 100 m²). The results from the 2017 survey are in blue; the results from the 2014-2016 surveys are included in black for comparison.





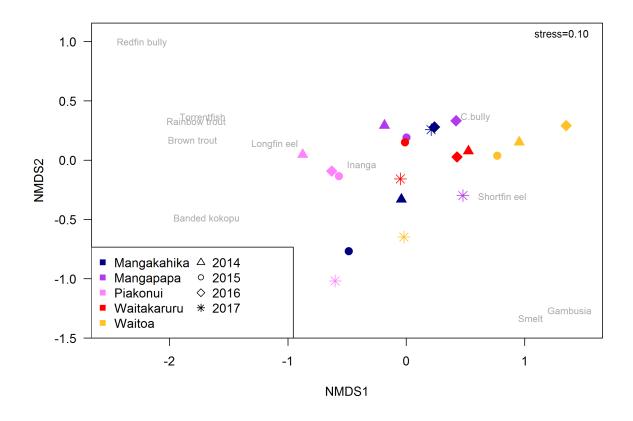


Figure 3-3: Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Piako catchment sites. 'Stress' is a measure of how well the distances on an ordination plot reflect actual 'ecological distance' (i.e., dissimilarity) between different communities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

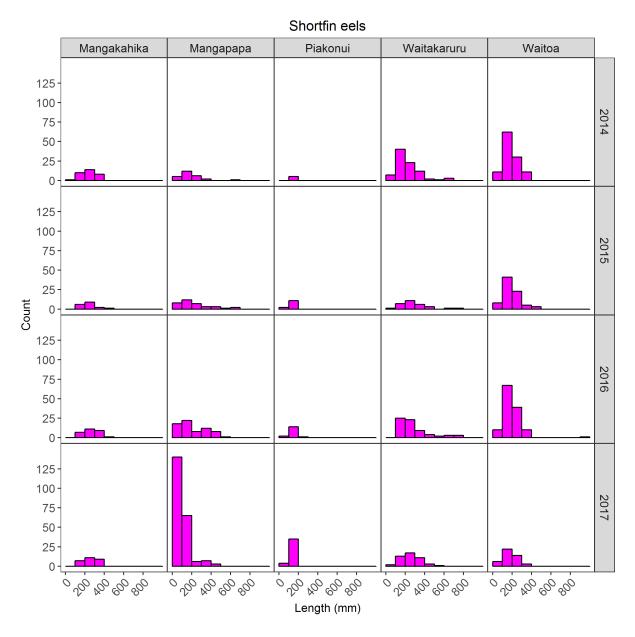


Figure 3-4: Size distributions for shortfin eels at each site in the Piako catchment between 2014 and 2017.

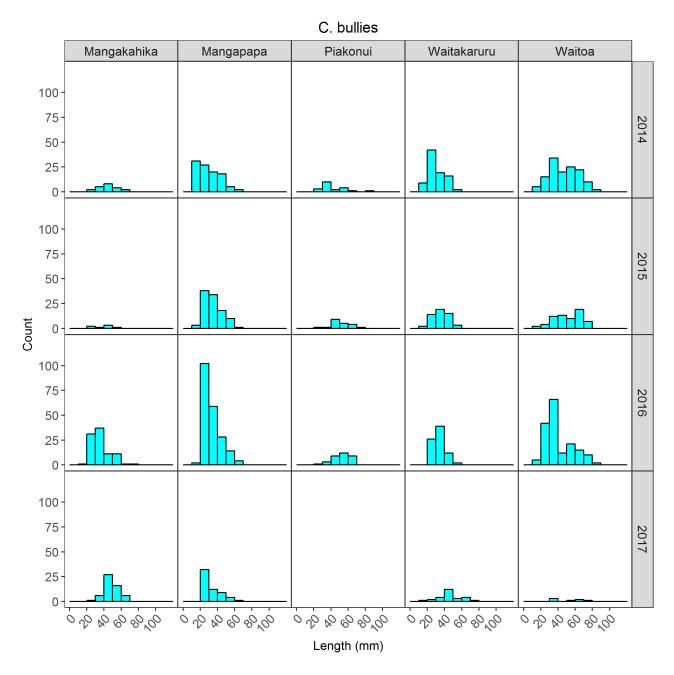


Figure 3-5: Size distributions for bullies at each site in the Piako catchment between 2014 and 2017.

Table 3-2:Size ranges (in mm) for most abundant fish (eels and bullies) captured in the Piako catchment in 2014-2017. The results from the 2017 survey are in blue; the
results from the 2014-2016 surveys are included in black for comparison.

Site	Year		Shortfin eel			Longfin eel			C. bully	
		min	max	median	min	max	median	min	max	median
1. Mangakahika	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	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	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	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	2017	95	151	109	455	935	695	-	-	-
	2016	94	240	115	-	-	-	24	70	53
	2015	97	163	111	438	642	455	30	79	50
	2014	105	185	115	400	650	620	30	87	38

3.1.3 Macroinvertebrates

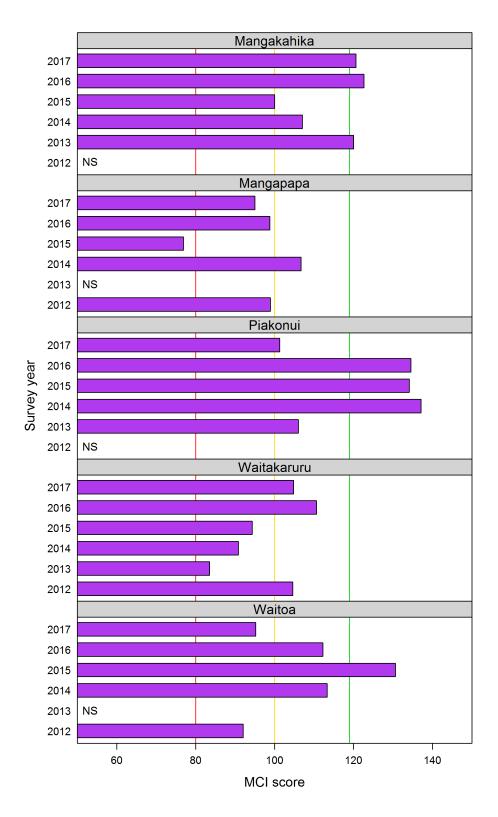
All sites were sampled according to the MfE protocol C1 for hard-bottomed streams, with an area of approximately 1 m² sampled at each site. A full taxonomic list for each site is included in Appendix D and is summarised at the taxa level in Table 3-3 according to the methods and requirements of Collier, Kelly (2005). Total taxa richness describes the total number of different types of macroinvertebrates present at a site. Very broadly speaking, higher total taxa richness, is expected to be associated with greater 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).

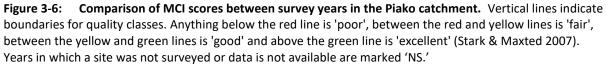
Invertebrate taxa richness was higher at all sites except Piakonui Stream in 2017 compared to 2016, continuing the increasing trend observed between 2014 and 2016 (Table 3-3). EPT richness also increased compared to past years in three sites (Mangakahika, Waitakaruru, and Waitoa Streams), but remained the same in Mangapapa Stream and declined in Piakonui Stream. Despite the increases in EPT and total richness, MCI scores were lower in 2017 than in 2016 in all sites (Figure 3-6). Nonetheless, the 2017 scores were within the range of variability observed over the previous years, except in Piakonui Stream (at that site the 2017 MCI score was the lowest yet reported). Three of the five sites remained in the same MCI category as 2016: Mangakahika Stream remained in the 'excellent' category, Waitakaruru Stream remained in the 'good' category, and Mangapapa Stream remained in the 'fair' category. Of the remaining sites, the MCI score in Piakonui Stream dropped from 'excellent' to 'good' and the MCI score in Waitoa stream went from 'good' in 2016 to 'fair' in 2017.

While declines in MCI score are generally considered a cause for concern, in this case the concurrent increases in taxa richness and number of EPT taxa in several sites suggest that habitat conditions have not deteriorated substantially. The decline in all invertebrate metrics for Piakonui Stream could be linked to the heavy rain in the area in the week prior to sampling, as this site in particular showed evidence of recent high flows (i.e., large amounts of debris high on the banks, etc.,) which could have temporarily displaced stream invertebrates. Next year's monitoring should help determine whether this year's low score was a one-off or a wider temporal pattern.

Table 3-3:Summary of macroinvertebrate results for the Piako monitoring sites in 2014-2017. The resultsfrom 2017 are in blue; the results from the 2014-2016 surveys are included in black for comparison. MCI scoresless than 80 are classified as 'poor,' scores 80-100 are 'fair,' scores 100-120 are 'good,' and scores greater than120 are considered 'excellent' (Stark & Maxted 2007).

Site	Year	Total taxa richness	EPT richness	%EPT	MCI
1. Mangakahika Stream	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	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	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	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	2017	15	7	24.6	101.3
	2016	33	23	76.1	134.5
	2015	34	20	86.8	134.1
	2014	28	15	83.5	137.1





3.1.4 Macrophytes & periphyton

Four of the five sites had no or low macrophyte cover present in 2017 (Figure 3-7). Of those four sites, macrophyte cover increased slightly in Mangapapa Stream, from approximately 10% to around 15%, and declined from approximately 25% to 15% in the Waitoa (Figure 3-7). Macrophytes remained absent from Piakonui Stream and below 5% in Mangakahika Stream, similar to previous years. In the fifth site, Waitakaruru Stream, macrophyte cover doubled from approximately 25% to 55%, largely due to increased abundance of watercress, *Nasturtium officinale/microphyllum*, an emergent macrophyte.

The periphyton enrichment index (PEI) scores have remained relatively stable over time at the Piakonui and Mangakahika sites (Figure 3-8 & Figure 3-9). Both the Magapapa and Waitoa streams had higher than usual PEI scores in 2016, but the scores in 2017 were lower and comparable to 2015 scores. Waitakaruru Stream also had a lower PEI score in 2017 than 2016. It is possible this pattern is linked to hydrologic conditions, as recent heavy rains prior to the 2017 sampling could have scoured away some periphyton material. Changes in periphyton sliminess index (PSI) scores, on the other hand, varied between sites (Figure 3-8 & Figure 3-9). PSI remained low in the Piakonui and Waitakaruru Streams, fairly constant around 20% in Mangapapa Stream, increased slightly in Mangakahika Stream (from approximately 5% to 10%), and decreased substantially in Waitoa Stream (from around 25% to around 5%).

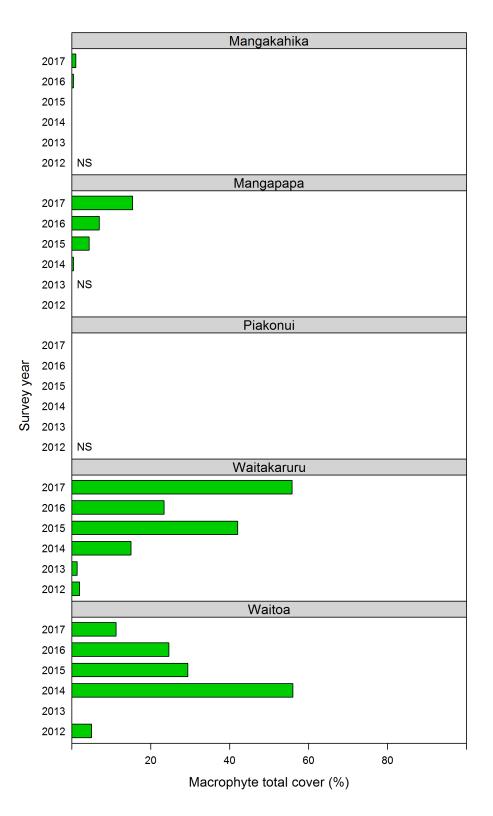


Figure 3-7: Comparison of macrophyte total cover (MTC) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

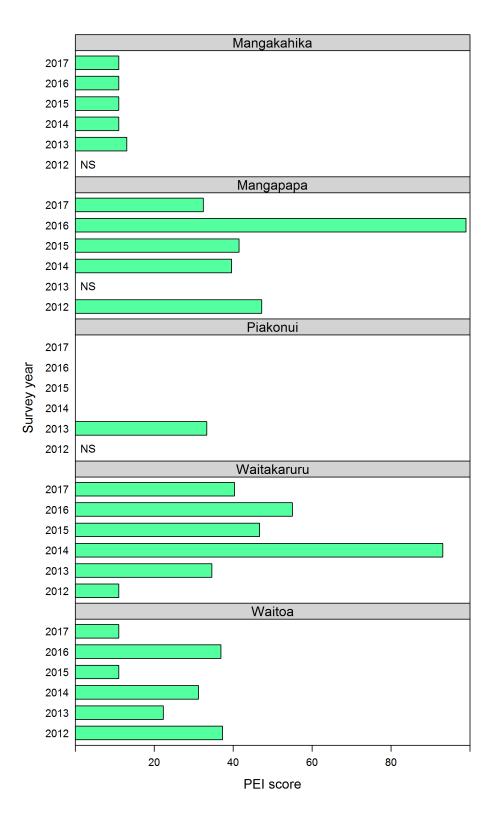


Figure 3-8: Comparison of periphyton enrichment index (PEI) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

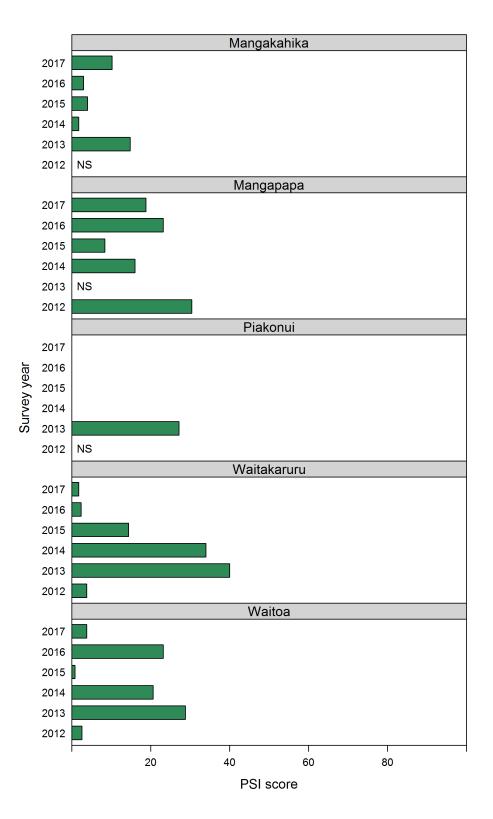


Figure 3-9: Comparison of periphyton sliminess index (PSI) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

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.

The habitat scores for the Piako sites have fluctuated between years, but show few overall trends (Figure 3-10). However, there has been a positive trend over time in Piakonui stream (Figure 3-10). Improved scores at this site are related to continued growth of riparian buffers as well as increased bank stability and reduced sediment deposition. Mangakahika Stream was the only site which scored lower in 2017 than 2016, primarily due to reduced bank stability. This site is not fenced, and it is therefore likely that the decreased score may reflect increased access and damage by livestock. Habitat scores for Mangapapa and Waitakaruru Streams were higher in 2017 than 2016, and close to the highest value ever reported for both sites (Figure 3-10). The improved scores occurred in conjunction with decreased sediment and increased heterogeneity of in-stream habitat as well as reduced periphyton cover.

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=26). 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 =0.37; Figure 3-11). Interestingly, the correlation appears to have been stronger in the early surveys (2012-2014), whereas in 2015-2017 there are 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 was weak but positive (ρ =0.27; Table 3-4). Fish species richness was also weakly positively correlated with habitat score (ρ =0.27; Table 3-4). However, this includes exotic fish species as well, which could alter the relationship. For example, salmonids are often indicative of higher habitat quality scores, but their presence could in turn affect richness of native fish species. Conversely, gambusia are often abundant in lower quality habitats where diversity is also lower, making it difficult to interpret results. The relative abundance of exotic and native fish at each site will also play a role in determining habitat-richness relationships.

Table 3-4:Correlation coefficients between the habitat score and various biotic indices for the Piako
catchment in 2017.

Biotic index	Spearman's rank correlation coefficient
MCI	0.37
Macroinvertebrate total richness	0.27
EPT richness	0.22
% EPT	0.18
Fish richness	0.27

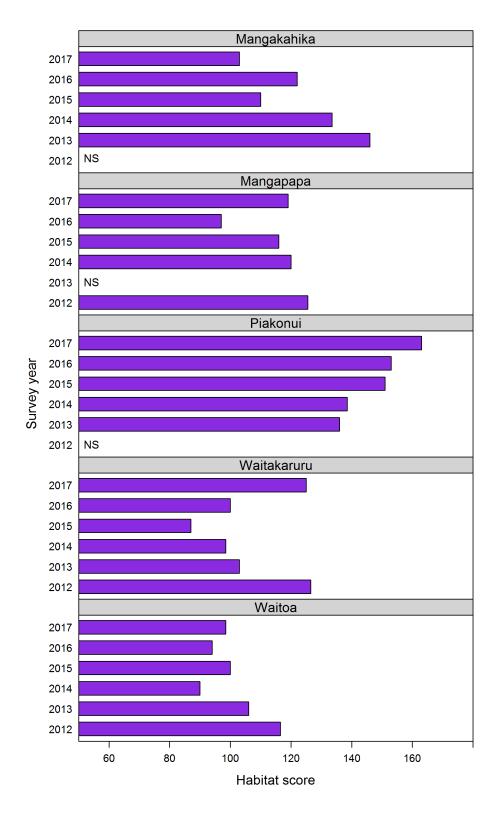


Figure 3-10: Comparison of habitat scores over time for the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

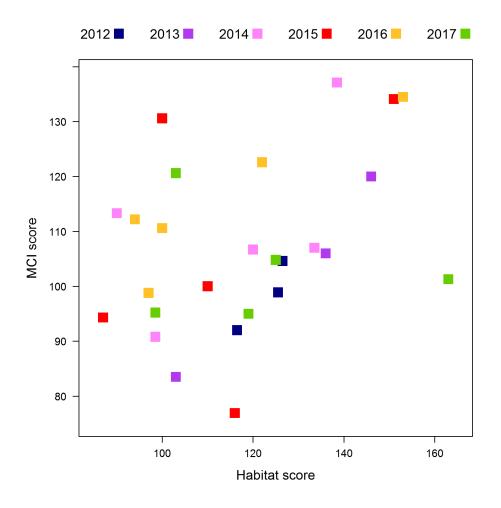


Figure 3-11: Scatterplot of habitat score against MCI score at the Piako survey sites in different survey years (ρ=0.37). No MCI score was available for the Waitoa site in 2013.

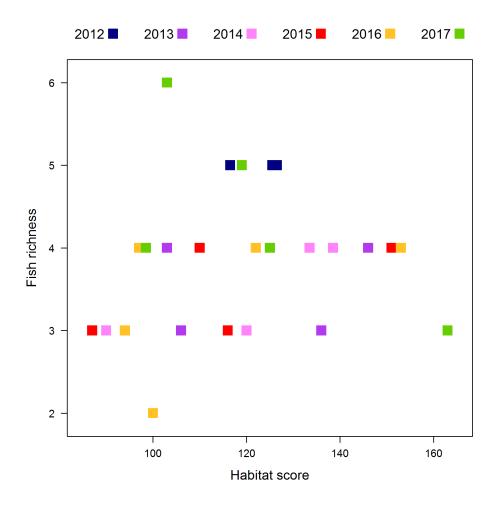


Figure 3-12: Scatterplot of habitat score against fish species richness at the Piako survey sites in different survey years (p=0.27).

3.2 Waihou catchment

3.2.1 Flow

Stream flows in the Waihou catchment are flashier in general than those in the Piako catchment, with more small-medium rain events throughout the year. Nonetheless, as in the Piako, flows tend to be low and stable over the summer period (Figure 3-13). However, 2016-2017 was an exception to this pattern, with several occasions of elevated flows in mid and late summer (Figure 3-13). The highest flows occurred in June to July and September to October 2016, similar to the Piako (Figure 3-13). There was also a medium-sized rain event during the sampling period in mid-February 2017 (Figure 3-13).

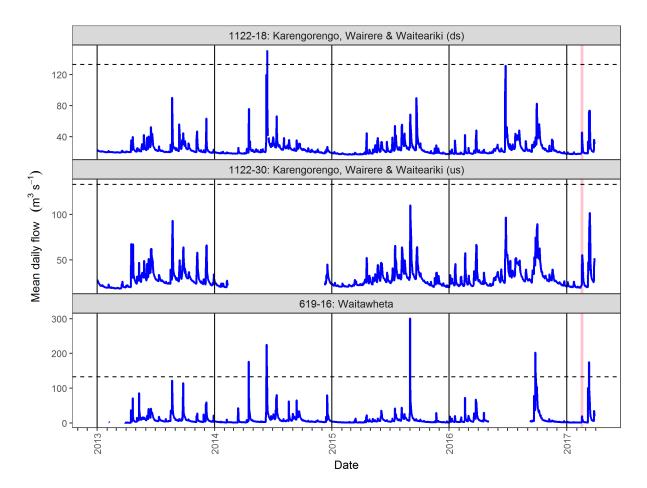


Figure 3-13: Mean daily flow (m³ s⁻¹) in the Waihou catchment between 2013 and 2017. Each flow monitoring site is listed first, followed by the survey sites for which it is the closest reference. Tick marks indicate months, the year label is located on the January tick mark. The 2017 sampling period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

3.2.2 Fish

Eleven different fish species were recorded among the five Waihou survey sites in 2017, eight of which were native and three of which were exotic species (mosquitofish, rainbow trout, and brown trout; Table 3-5). Shortfin eels were the only fish species present at all five sites, along with koura (freshwater crayfish). Freshwater shrimp (*Paratya curvirostris*) were also found at two sites. Longfin eels were recorded at four sites, though in the past they have been captured at all five sites. Banded kokopu were only captured at one site, similar to 2015, although it was a different site. Inanga were not captured at any of the sites, although they were present at one site in 2016 and in two sites in 2015. Redfin bully were captured for the first time in Paiakarahi Stream, but not in Waitawheta River, where they were found in 2016. *Gambusia affinis*, the invasive mosquitofish, was captured in Karengorengo Stream for the second year in a row. Paiakarahi Stream had the greatest species richness, with 7 different species, 6 native and 1 exotic (Table 3-5). Wairere Stream had the largest total abundance of fish, due to high numbers of bullies and shortfin eels.

The relative abundance of fish is compared between survey years for each site in Figure 3-14. A high abundance of macrophytes in Karengorengo Stream severely inhibited electric fishing; therefore it is

possible that the low abundances recorded in this site are underestimates caused by the low capture efficiency. When the site was mechanically cleared of macrophytes prior to sampling in 2016, the numbers of fish captured were much higher (Table 3-5). Exotic *Gambusia* were captured for the second year in a row, and a rainbow trout was also captured for the first time in this site in 2017 (though brown trout were present in 2014). Inanga were absent after being present in very low numbers (1 individual) in 2016 and 2015.

At the Paiakarahi sampling site, the abundance of shortfin eels, longfin eels, and torrentfish were consistent with ranges observed in the previous two surveys (Figure 3-14, Table 3-5). Abundance of bullies was lower than in 2016, but similar to 2015 numbers. There were more rainbow trout captured than in previous years, but no brown trout were present, unlike past years. Inanga and banded kokopu were also both absent for the second year in a row, though they were captured in low numbers in previous surveys.

In Wairere Stream, the relative abundances of both shortfin eels and bullies were higher in 2017 than in 2016 or 2015, but not as high as in 2014 (Figure 3-14, Table 3-5). The abundance of longfin eels was low, similar to previous years. Torrentfish and both species of trout were absent in 2017, though they have been captured consistently at this site in the past.

Shortfin and longfin eel abundances in Waitawheta River were higher in 2017 than in 2016, but still lower than in 2014 and 2015. Bully abundance, on the other hand, was similar to that recorded in past years. Both species of trout were present in 2017, but banded kokopu continued to be absent (last observed in 2014). Redfin bullies, which were captured for the first time at this site in 2016, were not found again in 2017.

Abundances of all shortfin eels and bullies were the lowest yet recorded in Waiteariki Stream in 2017 (Figure 3-14, Table 3-5). This may have been due to the heavy rain that occurred in the week prior to sampling, or because the water level was still high during sampling, which made electric-fishing difficult and less effective. Both bullies and small shortfin eels (<150 mm), which are the majority of eels captured in this site in previous years, may hide in the substrate and be more difficult to capture when water levels are deeper. Longfin eels and brown trout were captured in comparable numbers to previous surveys, probably because these species are rare in general, and thus the change in abundance is less noticeable. In addition, trout are more pelagic and thus easier to capture via electric-fishing in deep water than the smaller fish, which tend to stay near the streambed. Similarly, the longfin eels present are often in the largest size classes, which also prevents them from burrowing into the substrate. Banded kokopu were absent, also consistent with variable records from prior sampling (i.e., present in 2014 and 2016, but not 2015).

Community composition was more variable between than within the five Waihou sites (Figure 3-15). Unlike the Piako sites, the community composition in 2017 was similar to previous years, indicated by clustering together in ordination space. The one exception was Waiteariki Stream, which had much lower abundances of shortfin eels and bullies in 2017 than in past years, potentially due to the heavy rain and high flows. Interestingly, the community composition in Karengorengo Stream in 2017 was quite similar to the 2015 composition, which was also the last period of high macrophyte cover, whereas the composition in 2016, when macrophytes were cleared, was more dissimilar and separated in ordination space.

Size distributions show that shortfin eel population structure has remained consistent over time in all five Waihou catchment streams (Figure 3-16). As in the Piako catchment sites, shortfin eel size

distributions tended to be right-skewed with a greater proportion of small eels (Figure 3-16). There were very few large shortfin eels >400 mm at any site. In fact, in two sites, Paiakarahi and Waiteariki Streams, there were no eels >200 mm. This may indicate a lack of suitable habitat for large eels within these sites or high fishing pressure, with the former the more probable cause.

Except for Paiakarahi Stream, the few longfin eels captured at these sites were all larger than 250 mm (Table 3-6). The scarcity of small longfin eels (no longfin eels <200 mm caught in four of the five sites and only 4 individuals in the 5th site) suggests that recruitment of longfin eels in these streams has been poor in recent years, although it could also be an artefact of the limited sampling, as longfin elvers tend to have a patchy distribution.

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 3-17). In Paiakarahi Stream and Waitawheta River the size distribution remains fairly similar year-to-year, while in Karengorengo and Waiteariki Streams 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 (Figure 3-17). Wairere Stream, on the other hand, appears to have a cyclical two-year recruitment pattern; the size distributions in 2014 and 2016 had a similar bimodal pattern high numbers of both small bullies and large bullies, while the size distributions in 2015 and 2017 both had highest numbers of medium-sized fish (Figure 3-17).

Site	Year		ortfin eel		ngfin el		nid. el	C. I	oully		dfin ully		rrent- fish	In	anga	Sn	nelt	Gan	nbusia		ded opu		nbow rout		own out		nid. out	Ко	oura
		Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA	Α	RA
6.	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
Paiakarahi	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.	2017	70	33.8	-	-	16	7.7	11	5.3	-	-	-	-	-	-	7	3.4	4	1.9	-	-	2	1.0	-	-	-	-	12	5.8
Karengorengo	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.	2017	225	26.2	2	0.2	32	3.7	453	52.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	3.4
Wairere	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.	2017	12	1.2	4	0.4	-	-	18	1.8	-	-	3	0.3	-	-	-	-	-	-	-	-	-	-	2	0.2	-	-	8	0.8
Waiteariki	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.	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
Waitawheta	2016	8	1.3	3	0.5	-	-	96	15.3	15	2.4	-	-	-	-	-	-	-	-	-	-	1	0.2	-	-	-	-	10	1.6
	2015	12	2.9	17	4	-	-	53	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	-	-	25	6
	2014	23	4.5	16	3.1	-	-	64	12.6	-	-	-	-	-	-	-	-	-	-	1	0.2	-	-	3	0.6	-	-	10	2.0

Table 3-5: Results of 2014-2017 electric fishing surveys at the five Waihou catchment monitoring sites.

A = Number caught (abundance); RA = Relative abundance (individuals per 100 m²). The results from 2017 are in blue; the results from the 2014-2016 surveys are included in black for comparison.

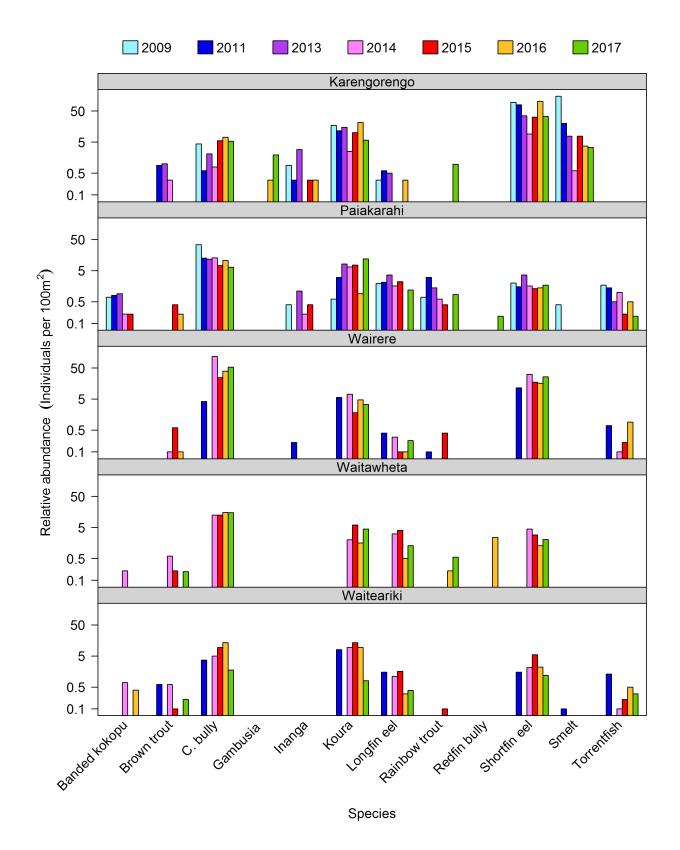


Figure 3-14: Comparison between the relative abundance of fish captured in the 2009, 2011, and 2013 - 2017 Waihou surveys. Wairere Stream and Waiteariki Stream were only sampled in 2011 and 2014-2017. The Waitawheta was only sampled in 2014-2017. Note the logarithmic y-axis.

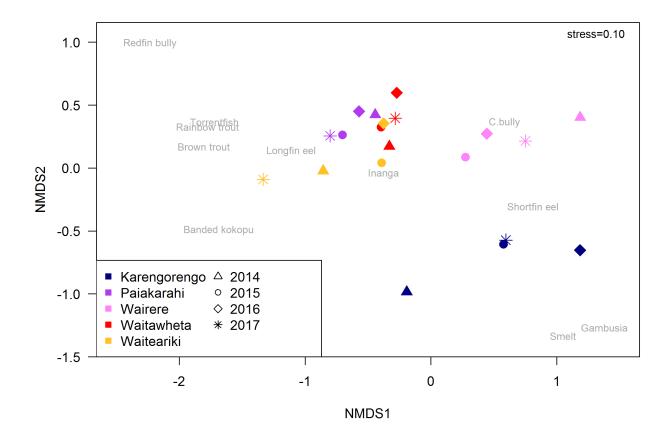


Figure 3-15: Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Waihou catchment sites. 'Stress' is a measure of how well the distances on an ordination plot reflect actual 'ecological distance' (i.e., dissimilarity) between different communities in the dataset. Stress values <0.2 are considered an acceptable representation of the data (Clarke & Warwick 2001).

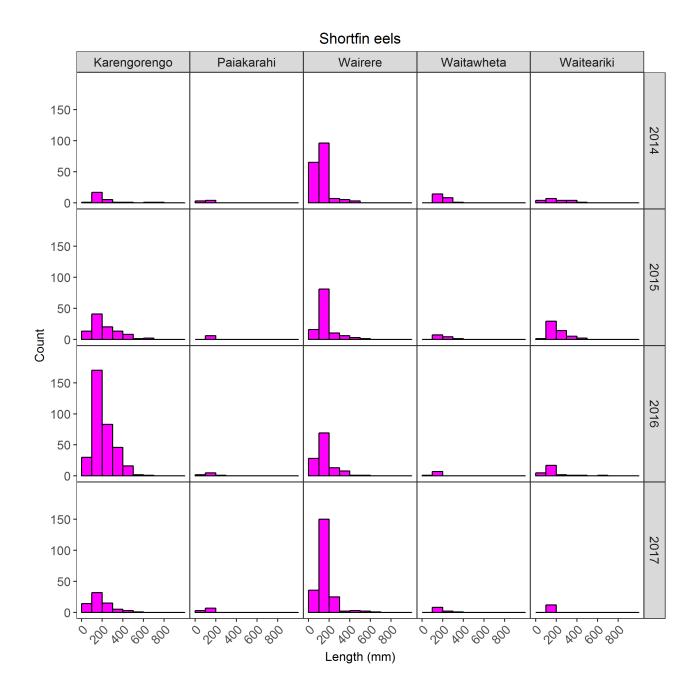


Figure 3-16: Size distributions for shortfin eels at each site in the Waihou catchment between 2014 and 2017.

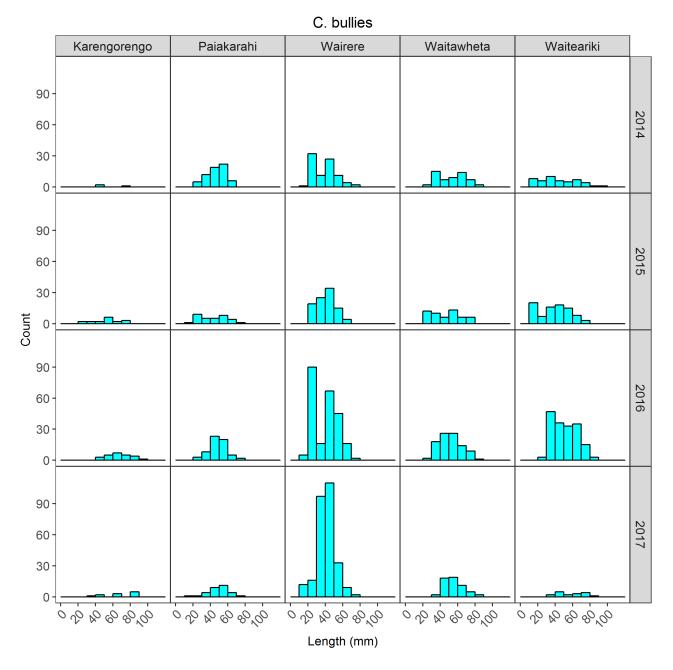


Figure 3-17: Size distributions for bullies at each site in the Waihou catchment between 2014 and 2017.

Table 3-6:Size ranges (mm) for most abundant fish (eels and bullies) captured in the Waihou catchment in 2014-2017. The results from the 2017 survey are in blue; the
results from the 2014-2016 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	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	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	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	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	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

3.2.3 Macroinvertebrates

Taxa richness was higher at four of the five Waihou catchment sites in 2017 than in 2016, and unchanged at the fifth site (Waiteariki Stream). EPT richness was also higher in 2017 at three sites, but unchanged in the fourth site (Karengorengo Stream) and lower in the fifth site (Waiteariki Stream). MCI scores, on the other hand, were lower in 2017 than in 2016 at all sites except Waiteariki Stream (Figure 3-18). The percentage of total individuals which were EPT taxa also declined at four of the five sites, with Wairere Steam the one exception.

Taxa richness was higher in 2017 than ever previously recorded at three sites: Paiakarahi, Wairere, and Waitawheta Streams. EPT richness was higher than ever before in Paiakarahi and Waitawheta Streams in 2017. The percentage of EPT individuals, however, was lower in 2017 than in 2016 at all sites except Wairere Stream (Table 3-5).

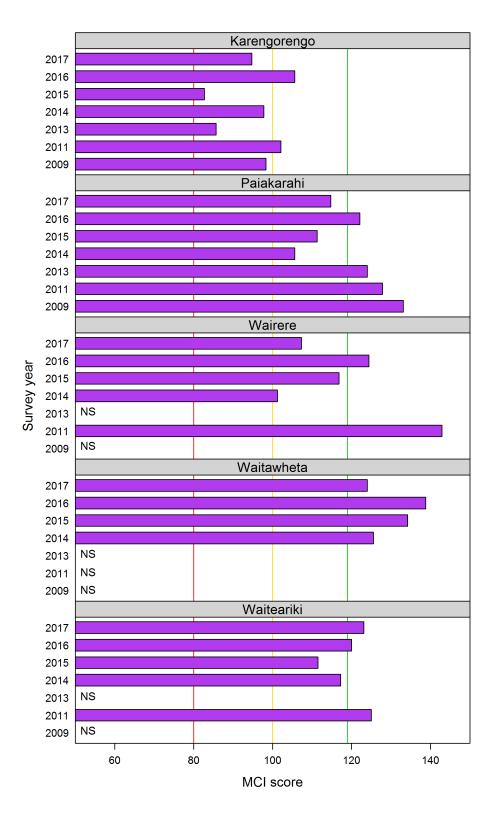
MCI scores declined from 'excellent' to 'good' at two sites, Paiakarahi and Wairere Streams, and from 'good' to 'fair' in Karengorengo Stream. However, both Waitawheta River and Waiteariki Stream remained in the 'excellent' category.

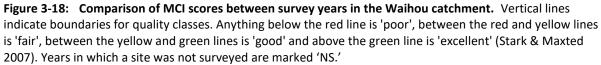
As in the Piako catchment sites, there does not appear to be strong correlation between EPT richness and MCI scores; for example in 2017 EPT richness increased but MCI declined at four of the five Waihou catchment sites, while at the fifth site EPT richness was lower in 2017 but the MCI score was higher. Whereas in 2016 both EPT richness and MCI scores improved at two sites, and EPT richness declined, but MCI increased at another two sites. The fifth site, Karengorengo Stream, highlights the disconnect, as EPT richness has remained constant over the last four years but the MCI score has varied considerably year to year.

The decline in MCI scores observed in 2017 may be associated with the heavy rainfall that occurred the week prior to sampling. However, Waiteariki Steam, which was one of the two Waihou catchment sites sampled after the rain and had much higher water level than in previous years, did not show large decreases in taxa richness or EPT richness and had an improved MCI score, suggesting that the rain and increased flows may not have had a large effect on invertebrate metrics.

Table 3-7:Summary of macroinvertebrate results for the Waihou monitoring sites in 2014-2017. Theresults from 2017 are in blue; the results from the 2014-2016 surveys are included in black for comparison. MCIscores less than 80 are classified as 'poor,' scores 80-100 are 'fair,' scores 100-120 are 'good,' and scoresgreater than 120 are considered 'excellent' (Stark & Maxted 2007).

Site	Year	Total taxa richness	EPT richness	%EPT	MCI
6. Paiakarahi Stream	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	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	2017	33	15	38.3	107.3
	2016	18	12	30.1	124.4
	2015	32	20	51.2	116.8
	2014	17	10	35.2	101.2
9. Waiteariki Stream	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	2017	40	28	38.3	124.0
	2016	33	26	42.9	138.8
	2015	31	22	25.6	134.2
	2014	29	21	23.5	125.5





3.2.4 Macrophytes & periphyton

Macrophyte cover was low at all the Waihou survey sites in 2017 except Karengorengo Stream, which had high coverage as it has in most past years (Figure 3-19). Although several sites had noticeable macrophyte growth for the first time in 2016, no (Waitawheta River and Waiteariki Stream) or very little (Wairere Stream) macrophytes were recorded in 2017, indicating that the previous year's increase was not the beginning of a trend.

Periphyton enrichment scores (PEI) were higher in all sites except Waiteariki Stream in 2017 compared to 2016 (Figure 3-20). However, the PEI scores at the four sites were all still within the range of previous reports for those sites. The PEI score in Karengorengo Stream was higher than ever before reported, 90%, due to the presence of long green filamentous algae. Conversely, the PEI score in Waiteariki Stream was low due to the absence of long filamentous green algae, which had been abundant in previous years. It is possible that algal mats were scoured during heavy rain and increased flows that occurred the week prior to sampling this site. Periphyton sliminess index (PSI) scores were higher in Paiakarahi and Wairere Streams in 2017 than previous years (except for 2015 in Paiakarahi Stream) (Figure 3-21), indicating greater prevalence of thin film algae in those sites. PSI scores remained fairly constant with past values in the other three sites.

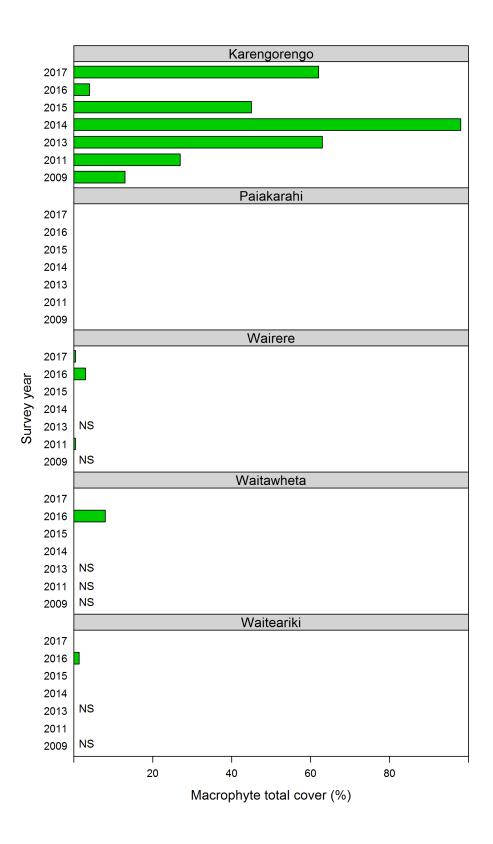
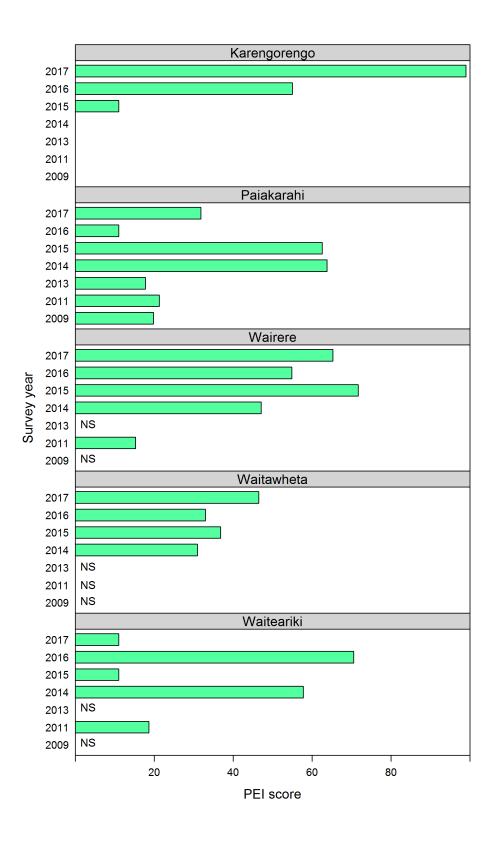
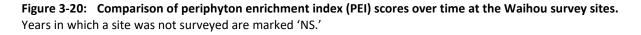


Figure 3-19: Comparison of macrophyte total cover (MTC) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'





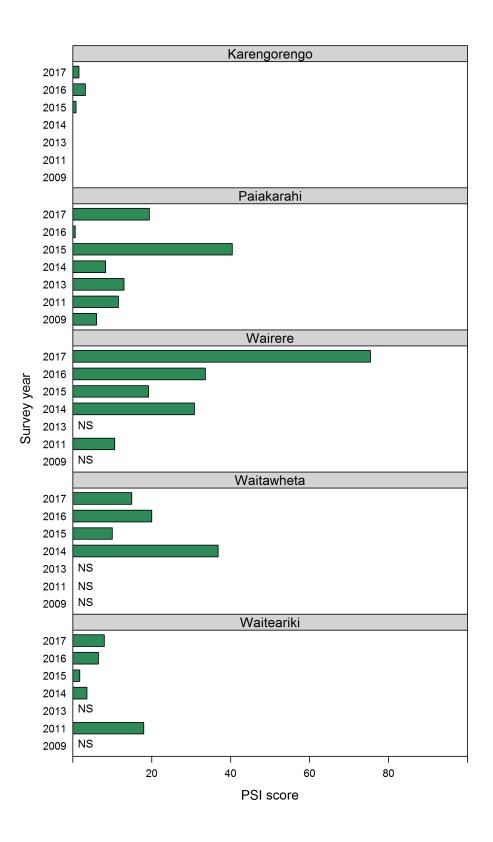


Figure 3-21: Comparison of periphyton sliminess index (PSI) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

3.2.5 Habitat quality scores

The habitat quality scores have fluctuated over time at all of the Waihou survey sites, but remain largely within the same range (Figure 3-22). Waitawheta River and Waiteariki Stream both show a positive trend in habitat scores over time since 2014. Karengorengo Stream had a substantial improvement in habitat quality score in 2017 compared to previous years. This improvement was primarily associated with increased riparian vegetation cover and bank stability. Waiteariki Stream also had a slightly higher habitat score in 2017 than 2016, due to reduced periphyton growth (or increased scour, as discussed above).

Correlations between total habitat scores and biotic indices indicated a positive association between the macroinvertebrate indices and habitat quality, as in the Piako catchment (n=23; MCI ρ =0.41; %EPT ρ =0.63) (Table 3-8 & Figure 3-23). There was also a positive correlation between fish species richness and habitat score at the Waihou sites (ρ =0.42; Figure 3-24), although it was not as strong as in past years (2015: ρ =0.69). This may be a reflection of the changes in fish species richness that have occurred in the past two years.

Biotic index	Spearman's rank correlation coefficient
MCI	0.41
Macroinvertebrate total richness	0.38
EPT richness	0.44
% EPT	0.63
Fish richness	0.42

Table 3-8:Correlation coefficients between the habitat score and various biotic indices for the Waihoucatchment in 2017.

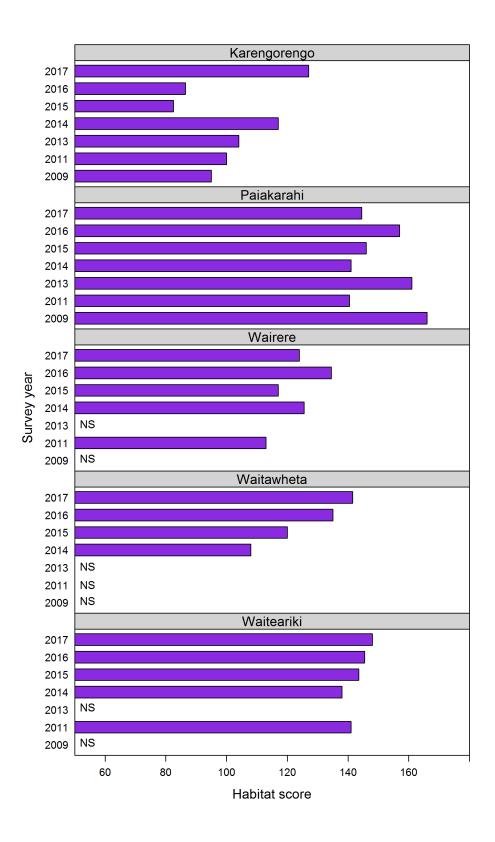


Figure 3-22: Comparison of habitat scores over time for the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

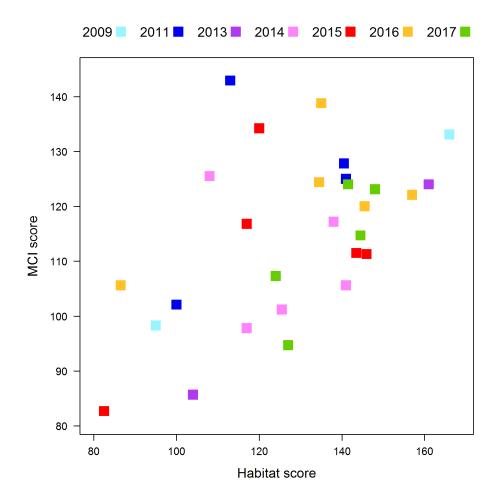


Figure 3-23: Scatterplot of habitat score against MCI score at the Waihou survey sites in different survey years (ρ =0.41).

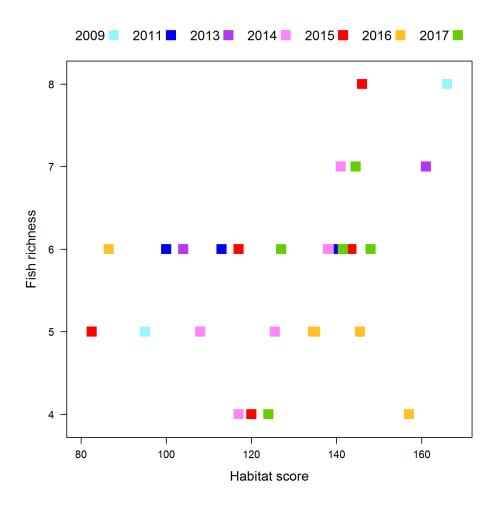


Figure 3-24: Scatterplot of habitat score against fish species richness at the Waihou survey sites in different survey years (ρ =0.42).

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, changing flows and river channel engineering. Changes in status over time will also be driven by a combination of natural variability in environmental and biotic conditions (i.e., wet v. dry years; warm v. cold years; good v. bad recruitment; high v. low survival), and human induced changes to the environment, e.g., water abstraction, pollutant discharges, land drainage and stream restoration.

Ecological monitoring is essential to understanding ecological status and trends. Therefore five sites were chosen in each of the Waihou and Piako catchments for annual ecological monitoring with the aim of supporting the water allocation decision making process. This recommendation was based on attaining a compromise between spatial coverage of the catchments and characterising natural interannual variations in the biotic communities. The ten sites are representative of a range of river types typical of each catchment (i.e., lowland, upland, more modified, less modified, different tributaries), with the aim of providing a broad catchment scale overview of ecological status. The ten sites have now been monitored for four years (2014 – 2017), 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).

The results of the 2017 monitoring may have been complicated by the rain event which occurred mid-way through the sampling period. Although flows remained well-below the bed-moving cut-off which would have required a two-week stand-down period, we observed lower abundances of fish and invertebrates in 2017 than in past years primarily in sites sampled after the heavy rain. There are several possible explanations for these results. First, there is a question of how well flow measured at the nearest gauging station represents changes in flow within the sample sites, which are smaller tributaries of the larger streams and rivers the gauging stations are located on. The relative increase in flow in the smaller tributaries may be greater than further downstream. Second, it is difficult to determine whether fewer fish were captured because they were absent due to physical displacement or avoidance behaviour, or because electric-fishing efficiency decreases in deeper water, and therefore we may have simply missed more fish in sites with increased flow post-rainfall. Thus, the 2017 results may indicate that increases in flow below the threshold may still have impacts on fish and invertebrate communities, we are currently unable to definitively attribute the observed declines in fish and invertebrate abundance with the rain event.

4.1 Piako catchment

The total number of fish caught in the 2017 survey was slightly lower, but similar to the total number of fish caught the previous year at all sites except Waitoa, which had much lower fish abundance in 2017. In general, the relative abundance of shortfin eels was higher than in past years, but the relative abundance of bullies was lower. Galaxiids (inanga, banded kokopu, and koaro) were found in some sites in which they had not been previously captured, but were absent from others in which 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.

Community composition was similar to that in previous years in three sites, Mangakahika, Piakonui, and Waitakaruru Streams, but differed in 2017 in Mangapapa and Waitoa Streams, primarily due to the large reduction in bully abundance in those sites.

Genetic analysis was conducted on a subsample of three bullies per site, but there was no clear clustering of cytochrome b sequences between common and Cran's bullies, therefore it remains uncertain which of the two species were present in each site. In general, the bullies from the two catchments (Waihou versus Piako) cluster somewhat separately, although some tributaries from both catchments fall in the space between the two clusters (Figure E-1). This could be indicative of a difference in the dominant species in each catchment. However, the lack of clear differentiation is likely due to either interbreeding and hybridization between the two species or misidentification of the original samples used to establish a baseline genetic sequence of *G. basalis* (Jonathan Banks, Cawthron Institute, personal communication), making definitive identification currently difficult. We hypothesize that taxonomic identification of the original samples could have been confused by morphological differences between migratory and non-migratory common bullies. Further sampling and sequencing will be required to resolve this question (see recommendations).

Comparison of size distributions between years indicated that shortfin eel population dynamics have remained consistent, with the greatest proportion of eels in the middle size classes (100-200 mm and 200-300 mm) each year. One exception to this pattern was the large number of small (< 100 mm) eels found in Mangapapa Stream in 2017. Large eels also continued to be absent at two (Mangakahika and Piakonui) of the five sites. Bully size distributions, on the other hand, have been more variable between years, and show different patterns in different sites, perhaps indicating the relative influence of migration versus local recruitment. For example, in Mangapapa Stream there are more small fish than large fish every year, possibly suggestive of migration of larvae into the stream every year, whereas in the other sites the peak abundance shifts between size classes in successive years, indicating an aging population followed by recruitment. The use of otolith microchemistry to determine the migratory history of the bullies at different sites (i.e., whether they are diadromous or locally recruited) could be informative for better understanding these dynamics. Furthermore, this may assist with clarifying the species differentiation between common bullies (generally considered to be diadromous in rivers) versus Cran's bullies (considered to be non-diadromous).

Macroinvertebrate community index scores were lower in all Piako sites than the previous year, but within the range of variability observed over time in all but one site (Piakonui). Although decreasing MCI scores are often associated with declining stream health, Mangakahika and Waitakaruru Streams also had higher percentages of EPT taxa than in past years, potentially an indication of improving stream health. Thus, it is possible that the low MCI scores were due to the heavy rainfall that occurred the week prior to sampling; the only Piako site which was sampled before the rain, Mangakahika Stream, had the smallest change in MCI score, while Piakonui, which showed the greatest evidence of recent flooding, had the largest decline.. Future monitoring will determine whether the low scores observed this year were a one-off due to the heavy rains and increased flow.

Habitat conditions and periphyton and macrophyte growth also affect macroinvertebrate and fish populations. Habitat scores were higher in 2017 than in 2016 at 4 of the 5 Piako sites. The improved scores were associated with reduced sediment deposition and reduced periphyton cover. However, it is important to note that both sediment and periphyton may have been scoured off during the high flows, and thus this year's data might not represent typical baseflow conditions.

4.2 Waihou catchment

In the Waihou catchment, the total number of fish captured was lower at four sites, and particularly low at two of those sites, in 2017 than in 2016. The two sites with substantially lower abundance were also the only two Waihou sites sampled after, rather than before, the heavy rain and high flow event, supporting our conjecture that the low fish abundances observed in the Piako catchment sites this year were associated with recent unusual hydrological conditions. Additionally, one of the two sites, Karengorengo Stream, likely also had low fish abundance due to decreased electric-fishing effectiveness in dense macrophyte beds, which had been cleared in 2016. The densities recorded for Karengorengo Stream in 2017 were comparable to those in other years when high macrophyte cover was present. Wairere Stream, which was sampled before the rain, was the only site in which total abundance was higher than the previous year, due to a large increase in the number of bullies. Inanga and banded kokopu were absent in 2017 from sites at which they had been previously found, although, as in the Piako catchment, this most likely means they are present in very low numbers and are rarely captured, rather than that they are truly absent some years and present other years.

Community composition in the Waihou sites in 2017 was similar to composition in previous years at all but one of the five sites. The dissimilarity in the remaining site, Waiteariki, was likely related to the low abundances following heavy rainfall in the week prior to sampling.

As in the Piako catchment, shortfin eel size distributions were similar across years, with the greatest proportion of eels in the 100-200 mm size class. There were also very few large shortfin eels at any site except Wairere Stream. Bully size distributions were more variable between years, with shifting peak abundances, and frequently bimodal, indicating the presence of multiple cohorts, and potentially suggesting populations were sustained by a mix of both migration and local recruitment.

Macroinvertebrate community index scores were lower in 2017 than in 2016 at four of the five sites, but not outside the range of scores previously observed. Interestingly, EPT richness increased at three of the four sites in which MCI scores dropped (and in the remaining site EPT richness did not change), while the one site which had a higher MCI score in 2017 had lower EPT richness. This suggests that the lower MCI scores did not result from losses of EPT taxa.

Lower MCI scores may be associated with increased periphyton cover, as all four sites at which MCI scores declined had higher periphyton enrichment scores in 2017 than 2016. Waiteariki was the one site at which periphyton cover was much lower than the previous year, probably because this was the one Waihou site sampled after the heavy rain, during which benthic scouring likely occurred. Waiteariki was also the only site at which the MCI score was higher in 2017 than in 2016, although both EPT richness and percent EPT were lower this year.

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 2014). 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 2017 survey results were complicated by the rain event which occurred halfway through the monitoring work. This has made it difficult to compare the data collected this year to previous years. On the other hand, however, it has provided some 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 (or a proxy such as water level), 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. 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 genetic work is needed to resolve the Cran's or common bully question. First, a reliable Cran's bully sequence needs to be identified by collecting and comparing samples from other known populations of Cran's bullies outside the Waihou and Piako catchments. Additionally, juvenile bullies from the Waihou and Piako sites should be collected and sequenced, as it was the presence of these smallest size classes that initially suggested non-migratory populations and may have led to the mistaken identification as Cran's.
- Otolith samples could be collected from all bully samples collected for the genetic analyses and their microchemistry analysed to determine whether they have a diadromous or potamodromous life-history. It has generally been assumed that common bullies in running waters typically have a diadromous life-history, whereas Cran's bullies are potamodromous, so this could help with confirming species differentiation between sites.

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Appendix A Habitat assessment forms

Stream name: Mangak									
	Sa	ample number: 4		Date: 14	1/02/20	017 1	īme	: 14:36	
GPS coordinates	D	ownstream:		E 18186	98	1	V 583	38814	
	U	pstream:		E 18186	518	1	V 583	38767	
Channel & riparian f	eatures			Instrea	m hyd	draulic co	ndit	ions	
Canopy cover:						asured reac			
Open	Partly shad	led Very s	haded						
Fencing:	Dominant ripa	arian vegetation:		Stream	width (active cha	nnel): 2.27m	
None/ineffective	Crops	Retired veg	getation	Stream	width (water): 1.8	34m		
One side/partial	Pasture	Native shr	ub	Stream	depth:	0.20m			
Complete	Exotic trees	Native tree	es	Surface	velocit	y: <1 m/s			
Water quality									
Temperature:	18.5	°C		Conduc	tivity:	1	.76.8	3 μS	5 cm⁻¹
Dissolved oxygen:	80.3	%		7.52		r	ng l ⁻ⁱ	1	
Turbidity:	Clear	Slightly turbid	Highly t	urbid	Stain	ed		Other	
Stream-bottom subs	strata								
Compaction (inorganic	substrata):			% surfic		rganic sub	strat	um size	
Assorted sizes tightly p	acked &/or ove	rlapping		Substra		Dimensio	on	Percen	tage
Moderately packed wi				Bedrock		-		0	0
Mostly a loose assortm				Boulder		>256mm		1	
, No packing/loose assor		•		Cobble		>64-256mm		80	
Embeddedness:				Gravel		>2-64mm		15	
(% gravel-boulder particles	s covered by fine	sediment)		Sand		>0.06-2mm		3	
<5% 5-25%	26-50%	51-75%	>75%	Silt		0.004-0.06n	nm	0	
I	I			Clay		<0.004mm		1	
Organic material (%	cover)			Habita	t type	s sampled	ł		
Large wood (>10cm dia	imeter)			(% of eff	ort)				
<5% 5-25%	26-50%	51-75%	>75%	Stones:		89%			
Coarse detritus (small v	wood, sticks, lea	aves etc., >1mm)		Wood:		1%	Ri	ffles:	35 %
< 5% 5-25%	26-50%	51-75%	>75%	Macrop	hyte:	%	Ru	uns:	65%
Fine (<1mm) organic de	eposits			Edges:		10%			
<5% 5-25%	26-50%	51-75%	>75%	Numbe	r of inv	ertebrates	retu	irned:	
Instream plant cove	r (% streambed	l area)		Koura: \	(5	hrin	nps: N	
Filamentous algae & m	ats:			Crabs: N	1	n	Auss	els: N	
< 5% 5-25%	26-50%	51-75%	>75%	Other:					
Macrophytes:				Mussel	type:				
<5% 5-25%	26-50%	51-75%	>75%	Hyridell	а	(Cucu	merunio	
Mosses/liverworts:									
<5% 5-25%	26-50%	51-75%	>75%						

Wadeable Hard-E Qualitative Habitat A						She	et													
Stream name: Mang					o cinci	ono			Site ı	numt	oer: :	374-4	1							
Sample number: 4	antai	inte		A	sses	sor:	Pete			-		-		e: 14	/02/2	2017	,			
Campio nambon i										Cate	aor		Date							
Habitat parameter		0	ptim	al			Sub	oopti		Care	.ge. ,		argir	nal				Poo	r	
1. Riparian vegetative zone width	•	vege >10r	n inuou	n buff us &	er	•	is <1	tation 0m	n buff ntinu		•	Path and/o Most over	or sto	ock	ent	•	Hur	aks fr nan a ious	•	
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: 6	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 6.5		<u> </u>		<u> </u>					<u> </u>											<u> </u>
2. Vegetative protection	•	imme ripar cove vege Tree store non- pres Vege	ediate ian zo red b etation s, un ey shi wood ent etativ	ones by nat der- rubs o ly pla	ive or nts	•	nativ Disru Bank	ered n re veg uption ks ma red b	nainly getati n evic	on lent	•	Bank cove mixtu grass black & intri spec Vege disru Bare cropp vege com	red b ure of ses/s berry roducties etation ption soil/ bed tatior	y hrubs y, will ced n obvi close	ow	•	cove gras Disi stre veg high Gra graz Sigi	ss he	by & shru n of ank n very avily avily	ubs y ck
Left bank: 11	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:11	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	•	Eros failur abse	ent/mi of ba	ank inima	I	•	Infre area most over	quen s of e tly he % of	ly sta t, sm erosic aled bank	all In	•	Mode unsta 30-60 reach of ere High poter flood	able 0% o n has osion eros ntial c	f ban area i	IS	•	Mar area	100% erosi	of ba	ink
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: 5	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 6.5																		1		
4. Frequency of riffles	•	frequ Dista riffles strea	uent ance s divi am wi ety of	ativel betwe ded k dth= habi	een by 5-7	•	Dista riffles	s infre ance s divi	ce of equer betwe ded b dth=7	een by	•	Occa or ru Botto provi habit Dista riffles strea 25	n om co de so at ince l s divie	ontou ome betwe ded b	rs een y	•	wate riffle Poo Dist riffle	nerally er, sh es r hab ance es divi am w	allow itat betwo ded t	een oy
Score: 17	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	•	char abse Strea	ent/mi am w	lredgi inima	I	•	chan Evide chan Rece chan	inel/d ence inel/d ent	anges Iredgi Iredgi Iredgi Iredgi nt	ing ist ing	•	Char chan exter Emb oring prese bank 40-80 chan disru	ges/onsive ankm structent of s 0% o nelize	nents, cture: n boti f read	/sh s h	•	with gab >80 read cha disr Inst	ion/ce % of	ement strear ced or habit	m r at
Score: 20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat parameter	-		atego ptim			Ha	bitat	para	amet	er			atego ptim			Ha	abitat	para	amet	er
6. Sediment deposition	•	point <20% affect sedir	bars	,	ent	•	bar for most grave fine s 20-5 affect	nt dep	tion, m nd or nent f bott	om	•	of ne sand sedir new 50-8 affec	or fir nent bars 0% of ted ment sits a ructio trictic	avel, ne on ol f bott f bott ns,	d & om	•	fine Incrededededededededededededededededededed	vy de matei eased elopm % of k iging uently s alm ent du ment ositior	ial bar ent oottor ost e to	
Score: 11	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 20 19 18 17 16 					•	regin If fas miss	4 nes p st/sha ing th e low	iresei Ilow i nen		•	2 of 4 veloc regin If fas slow miss low	city/de nes p t/shall /shall	reser llow o ow a	or	•	velo regir	inate city/de ne ally de	əptń	
Score: 8	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat						•	favor inver color Snag subn logs/ bank Fish com Mode of ha Can	nerge /unde ss/col cove mon erate abitat cons e nev	e for ate on ed rcut obles r varie types ist of	ety 5.	•	favou inver color Fish 60-9	tebra cove 0% si y mov dy de or ma hereo	e for te on r pato ubstra ved b ebris ay be	chy ate y	•	favo inve colo Fish abse Subs unst lacki Stab	strate able o	e for ite on r rare or bitats limite	ed
Score: 8	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	•	evide held Stab	ent or stone le su aces	n not n han es bstrat rough	d te	•	visib Stab Perip	ohyto le on le sul ohyto ous to	ston bstra n	es te	• •			er of		•	obvi >209 avai	ohyto ous & % cov able trates	proli er of	
Score: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 103	3																			

Wadeable Hard-Bot Stream name: Waitoa	Stream U/S				Assesso	or: Kath	iryn Reeve			
Site number: 1249-12		Samp	ole number: 6		Date: 2		·		e: 9:10	
GPS coordinates			nstream:		E18319				03819	
		Upst	ream:		E18318				03808	
Channel & riparian	features				Instrea	am hvo	draulic co	ond	itions	
Canopy cover:						•	asured read			
Open	Partly s	haded	Very s	haded					-	
Fencing:	Dominant	riparia	n vegetation:		Stream	width	(active cha	nne	el): 6.8 m	
None/ineffective	Crops		Retired veg	getation	Stream	width	(water): 1.	9 m	l	
One side/partial	Pasture		Native shru	ub	Stream	depth:	0.25 m			
Complete	Exotic tree	S	Native tree	es	Surface	veloci	ty:			
Water quality										
Temperature:	19		°C		Conduc	tivity:		109	.2 μS	cm ⁻¹
Dissolved oxygen:	95.9		%		8.88			mg	⁻¹	
Turbidity:	Clear		Slightly turbid	Highly t	urbid	Stair	ned		Other	
Stream-bottom sub	strata									
Compaction (inorgani	c substrata):				% surfic		rganic sub	stra	atum size	
Assorted sizes tightly p	backed &/or	overla	oping		Substra	tum	Dimensi	on	Percent	tage
Moderately packed w	ith some ove	erlappi	ng		Bedroc	k	-		10	
Mostly a loose assortn	nent with litt	le over	lap		Boulde	r	>256mm		20	
No packing/loose asso	rtment easil	y move	ed		Cobble		>64-256mr	n	20	
Embeddedness:					Gravel		>2-64mm		15	
(% gravel-boulder particle	es covered by f	ine sedi	ment)		Sand		>0.06-2mm	n		
<5% 5-25 %	6 26-5	50%	51-75%	>75%	Silt		0.004-0.06	mm		
					Clay		<0.004mm		35	
Organic material (%	cover)				Habita	t type	s sample	d		
Large wood (>10cm di	ameter)				(% of eff	ort)				
<5% 5-25%	% 26-5	50%	51-75%	>75%	Stones:		95%	5		
Coarse detritus (small	wood, sticks	, leave	s etc., >1mm)		Wood:		%	F	Riffles:	50%
< 5% 5-25%	% 26-5	50%	51-75%	>75%	Macrop	hyte:	%	F	Runs:	50%
Fine (<1mm) organic c	leposits				Edges:		5%			
< 5% 5-25%	% 26-5	50%	51-75%	>75%	Numbe	r of inv	ertebrates	s ret	urned:	
Instream plant cove	er (% stream	bed ar	ea)		Koura:	Y		Shri	mps: N	
Filamentous algae & n	nats:		, ·		Crabs: I	N		Mus	ssels: N	
< 5% 5-25%	% 26-5	50%	51-75%	>75%	Other:					
Macrophytes:	I		1 1		Mussel					
< 5% 5-25%	6 26-5	50%	51-75%	>75%	Hyridel	la		Сис	umerunio	
Mosses/liverworts:	. 1		1 1							
<5% 5-25%	6 26-5	50%	51-75%	>75%						
~3 % 5-257										

Stream name: Waitoa	Strea	am U	/S					9	Site n	umb	er: 12	249-1	.21							
Sample number: 6				A	ssess	or: K	athry	/n Re	eve				Date	: 20/	02/2	017				
										Cate	gory									
Habitat parameter		C	Optim	al			Sub	ooptii	mal			Μ	argir	al				Poor		
1. Riparian vegetative zone width	•	vege >10r	inuou		er	•	<10m	tation			•	Pathy and/o Most	or sto	ck		•		iks fre nan ac ous	•	<u></u>
Left bank: 3	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 4	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 3.5					1			1		1					1				1	
2. Vegetative protection	• •	imm zone nativ Tree shru woo pres Vege	c surfa ediate es cove ve veg s, und bs or r dy pla ent etative uption	e ripar ered b etatio er-sto non- nts	ian y n orey	•	cover nativ Disru Bank	surfa red m e vege ption s may red by try	ainly etatio evide be	n ent	• •	Bank cover of gra black & intri speci Vege disru Bare cropp comr	red by asses/ berry roduc es tation ption soil/c ped ve	y mixt /shrub , willo ed obvio losely	os, ow ous	•	cove & sh Disre strea vege high Gras graz Sign	s heav	y gras of nk very vily	c
Left bank: 3	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 5	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 4																				
3. Bank stability	•	Eros failu abse	nt/mi of bai	ank nimal		•	Infree areas	, s of er ly hea % of b	, sma osion iled o	II	•	Mode unsta 30-60 reach erosid High poter flood	ible)% of i has a on erosic ntial d	bank areas	of	•	Mar 60-1	able y eroc 00% c erosio	of ban	k
Left bank: 5	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 3	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 4				•			<u> </u>					<u> </u>					<u> </u>			
4. Frequency of riffles	•	freq Dista riffle strea	es rela uent ance b s divio am wio ety of	etwee led by dth=5	en / -7	•	Dista riffles	s infre	quen etwee led by	en /	•	Occas run Botto provi habit Dista riffles strea 25	om co de so at nce b s divic	ntour me etwee led by	s en /	•	wate riffle Poor Dista riffle	erally er, sha es r habit ance b es divio am wio	llow at etwe ded b	y
Score: 17	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	•	char abse Strea	nges to inel/d int/mi am wi nal pa	redgir nimal th	Ig	•	chan Evide chan Recei chan	nel/dr	edgir f past edgir	ng : ng	• •	Chan chang exter Emba ing st prese banks 40-80	ges/d nsive nkme ructu ent on	ents/s res both reach	hor	•	gabi >809 reac or d Instr	ks shot on/ce % of st h char isrupte ream h red/ab	ment ream nneliz ed nabita	ed

Habitat parameter		Ca	atego	ory		На	bitat	para	mete	r		Ca	itego	ry		Ha	ıbitat	para	mete	er
Habitat parameter		С	ptim	nal								0	ptim	al						
6. Sediment deposition	•	point <20% affec sedir	bars of b ted b		ent	•	form from or fin 20-50 affec	t depo	most I, san iment botto	ly d t m	•	Some new { fine s old & 50-80 affec Sedin at ob const bend	gravel edim new 0% of ted nent o struct	l, sand ent or bars botto depos tions,	dor n m	•	fine Incre deve >80% chan frequ Pool abse sedir	mate eased lopm 6 of b	bar ent ottom v ost e to	
Score: 13	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Velocity/depth regimes	•	regin Slow	nes pi /deep /shall shallc	ow,		•	regin If fas	tity/de nes pr t/shal ng the	esent low is		•	2 of 4 veloc regim If fast slow/ missi	ity/de nes pr t/shal (shallo	esent low o ow are	r e	•	velo regir	city/d ne	d by 1 epth ep/slo	
Score: 9	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	•	favou inver color varie debr mats Snag logs/ bank provi fish c	urable tebra hisatio ty of s, riff s/ sub unde s/cob des a over : not l	nte on & v wood fles, ro omerg rcut	y oot ed ant	•	favou inver color Snag logs/ bank Fish o Mode of ha Can o	0% sul urable tebra hisatio s/ sub under s/cob cover erate bitat consis mater	for te merg cut bles comn variet types t of so	ed non sy	•	10-30 favou inver colon Fish c 60-90 easily foot Wood or ma smot sedin	irable tebra isatio cover 0% sul y mov dy del ay be hered	for te n patch bstrat ed by bris ra	y e	•	favo inver color Fish abse Subs or la Stab lacki	urable rtebra nisatie cover nt trate cking le hat	ite on rare o unsta bitats limite	ble
Score: 12	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	•	evide held Stabl	ent or stone e sub	n not n hand es ostrate ough 1	2	•	visibl Stabl	hytor e on s e subs hytor uch	tone: strate		•	Perip <20% availa	, cove	r of		•	& pr >20%	, olific 6 cove	n obvi er of substr	
Score: 13	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 98.5																				

Stream name: Manga	papa Stream				Assesso	or: Kath	ryn Reeve			
Site number: 433-14		Samp	le number: 7		Date: 2	0/02/2	017 1	Fime:	14:55	
GPS coordinates		Dowr	nstream:		E 18367	783	1	N 580)9932	
		Upstr	eam:		E 18367	750	1	N 580	9802	
Channel & riparian	features				Instrea	am hyo	draulic co	nditi	ions	
Canopy cover:					Estimate	d or me	asured reac	h aver	rage:	
Open	Partly s	haded	Very sh	aded						
Fencing:	Dominant	riparia	n vegetation:		Stream	width	(active cha	nnel)	:	
None/ineffective	Crops		Retired vege	etation	Stream	width	(water): 3.7	7 m		
One side/partial	Pasture		Native shrul	c	Stream	depth:				
Complete	Exotic tree	S	Native trees	i	Surface	velocit	ty:			
Water quality										
Temperature:	20.7		°C		Conduc	tivity:	1	100	μS	cm ⁻¹
Dissolved oxygen:	85.0		%		8.55		r	ng l ⁻¹		
Turbidity:	Clear		Slightly turbid	Highly t	urbid	Stair	ned	(Other	
Stream-bottom sub	ostrata		•							
Compaction (inorgani	ic substrata):	-SEE B	EDROCK		% surfic		rganic sub	strat	um size	
Assorted sizes tightly	packed &/or	overlap	ping		Substra	tum	Dimensio	on	Percen	tage
Moderately packed w	ith some ove	rlappin	g		Bedroc	(-		95	
Mostly a loose assortr	nent with litt	le over	lap		Boulder		>256mm			
No packing/loose asso	ortment easily	y move	d		Cobble		>64-256mm	n		
Embeddedness:					Gravel		>2-64mm			
(% gravel-boulder particle	es covered by f	ine sedi	ment)		Sand		>0.06-2mm			
< 5% 5-25	% 26-5	50%	51-75%	>75%	Silt		0.004-0.06n	nm	5	
					Clay		<0.004mm			
Organic material (%	6 cover)				Habita	t type	s sampled	d		
Large wood (>10cm d	iameter)				(% of eff	ort)				
< 5% 5-25	% 26-5	50%	51-75%	>75%	Stones:		80%			
Coarse detritus (small	wood, sticks	, leaves	s etc., >1mm)		Wood:		%	Rif	fles:	709
< F 9/ F 2F	% 26-5	50%	51-75%	>75%	Macrop	hyte:	10%	Ru	ns:	309
< 5% 5-25	deposits				Edges:		10%			
Fine (<1mm) organic o		50%	51-75%	>75%	Numbe	r of inv	ertebrates	retu	rned:	
I	% 26-5				Koura:	Y	9	Shrim	ips: N	
Fine (<1mm) organic o			ea)				I .	Muss	els: N	
Fine (<1mm) organic (<5% 5-25	er (% stream		ea)		Crabs: I	N	ſ			
Fine (<1mm) organic o <5% 5-25 Instream plant cove	er (% stream nats:		ea) 51-75%	>75%	Crabs: I Other:	N	Г			
Fine (<1mm) organic o <5% 5-25 Instream plant cover Filamentous algae & r	er (% stream nats:	bed are	I I	>75%			ſ			
Fine (<1mm) organic (<5% 5-25 Instream plant cove Filamentous algae & r <5% 5-25	er (% stream nats: % 26-5	bed are	I I	>75% >75%	Other:	type:		Cucur	merunio	
Fine (<1mm) organic o <5% 5-25' Instream plant cove Filamentous algae & r <5% 5-25' Macrophytes:	er (% stream nats: % 26-5	bed are	51-75%		Other: Mussel	type:		Cucur	nerunio	

Stream name: Manga	арара	Strea	m					S	Site n	umb	er: 43	33-14	-							
Sample number: 7				A	ssess	or: K	athry	n Re	eve				Date	: 20/	02/2	017				
Habitat parameter		C)ptim	al			Sub	optii	mal	Cate	gory		argin	al				Poor		
1. Riparian vegetative zone width	•	>10n	tatior n inuou	ı buffe s &	er	•	<10m	tation			•	Pathy and/o Most	or sto	ck		•		aks fre nan ac ous	•	
Left bank: 5	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 3	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 4																				
2. Vegetative protection	•	imme zone nativ Trees shrul wood prese Vege	ediate s cove re veg s, und bs or r dy pla ent etative	nts	ian y n orey	• • •	cover nativ Disru Bank	surfa red m e vege ption s may red by try	ainly etatio evide be	n ent	• • •	cover of gra black & intr speci Vege disru	es tation ption soil/c ped ve	y mixt /shrut , willc ed obvio losely	us	•	cove & sh Disre strea vege high Gras graz Sign	s heav	y gras: of nk very vily	1
Left bank: 6	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: 6																				
3. Bank stability	•	Erosi failui abse	nt/mi of bai	ank nimal		•	Infree areas		, sma osion Iled o	II	•	Mode unsta 30-60 reach erosid High poter flood	ible)% of i has a on erosic ntial d	bank areas on	of	•	Mar 60-1	table iy eroo .00% c erosio	of ban	k
Left bank: 14	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 14	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 14																				
4. Frequency of riffles	•	frequ Dista riffle strea	uent ince b s divio im wio	tively etwee led by dth=5 habita	en / -7	•	Dista riffles	s infre	quen etwee led by	en /	•		om co de so at nce b s divic	ntour me etwee led by	s en	•	wate riffle Poor Dista riffle	erally er, sha es r habit ance b es divid am wid	llow at etwee ded by	/
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	•	chan abse Strea		redgir nimal th	-	•	chan Evide chan Recei chan	nel/dr	edgir f past edgir	ng : ng	•	prese banks 40-80 chani	ges/di nsive nkme ructu ent on s 0% of nelize	ents/s res both reach	hor	•	gabi >809 reac or d Instr	ks shoi on/ce % of st h char isrupte ream h red/ab	ment ream nnelize ed nabita	ed
Score:16	20	19	18	17	16	15	14	13	12	11	10	disru 9	pted 8	7	6	5	4	3	2	1
50016.10	20	15	10	/	10	10	14	13		**	10	5	2	· '	3	5	4		-	1 -

		(Categ	ory		Ha	abita	t para	amet	er		Ca	itego	ry		На	bitat	par	amet	er
Habitat parameter			Optin	nal								0	ptim	al						
6. Sediment deposition	•	poin <209 affe	e/no is at bars % of b cted b ositior	prese ottom y sedi	nt	•	bar mos grav fine 20-5 affe Sligl	forma stly fro vel, sa sedir 50% o scted	nd or	om	•	fine s old & 50-80 affec Sedin at ob	gravel edim new 0% of ted nent o struct	l, sand ent or bars botto depos cions,	d or n m	•	fine Incre deve >809 chan freq Pool	mate ase lopr 6 of ging uent s aln nt d men	d bar nent bottor ly nost ue to	
Score: 20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Velocity/depth regimes	•	regii Slow slow fast,	locity/ mes pr v/deer v/shall /shallc /deep	resent o, ow,		•	regi If fa miss	ocity/o mes p		nt	•	regin If fas slow,	ity/de nes pr	esent low o ow are	r e	•	velo regir	city/ ne	ed by depth eep/s	
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	•	favo inve colo varie debi mat Snag logs banl prov fish Mus	% subs rtebra nisatio ety of ris, riff s gs/ sub /unde ks/cob vides a cover st not l sient	e for ite on & v wood iles, rc omerg rcut ibles bunda	y oot ed ant	•	favo inve colo Sna logs ban Fish com Moo of h Can som	ourable ertebr onisati gs/ su ks/co ks/co cove nmon derate	ate ion bmer ercut bbles r e varie t type ist of	ged		favou inver color Fish o 60-90 easily foot Wood or ma)% sul v mov dy del ay be hered	for te n patch bstrat ed by bris ra	y e	• • • •	favo inve colo Fish abse Subs or la Stab	urab rteb nisat cove nt trate ckin le ha ng o	ion r rare unsta g bitats r limit	or
Score: 13	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	•	evid ston Stab	ole sub aces r	n hand strate	1	•	visik Stak Peri	ole on ole su iphyto	on not stone bstrat on o toue	es e	•	<20%	hytor cove able s	r of		•	& pr >20%	olific 6 co	ver of subst	
Score: 10	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 119																				

Stream name. Walta	akaruru Stre	am			Assess	or: Pe	ter Williar	ns		
Site number: 1231-5	54	Samp	ole number: 3		Date: 1	4/02/2	2017	Time	: 8:46	
GPS coordinates		Dowr	nstream:		E 1817	745	1	N 58	15748	
		Upstr	eam:		E 1817	903	1	N 58	15670	
Channel & riparia	an feature	s			Instrea	am h	ydraulic	cor	nditions	5
Canopy cover:					Estimate	d or m	easured re	ach a	average:	
Open	Partly s	shaded	Very sł	naded						
Fencing:	Dominant	t riparia	in vegetation:		Stream	width	(active cl	hann	iel):3.64r	n
None/ineffective	Crops		Retired veg	getation	Stream	width	(water): 2	2.0m		
One side/partial	Pasture		Native shru	du	Stream	depth	1: 0.6m			
Complete	Exotic tr	ees	Native tree	S	Surface	e veloc	city:			
Water quality										
Temperature:	19.4			Conduc	tivity:		134	μ	S cm ⁻¹	
Dissolved oxygen:	104.2		%		9.58		r	mg l ⁻	1	
Turbidity:	Clear		Slightly turbid	Highly	turbid	Stair	ned	(Other	
Stream-bottom s	ubstrata									
Compaction (inorg	anic subst	rata):			% surfi compo		norganic :	sub	stratum	size
Assorted sizes tight	y packed &/	or over	rlapping		Substra	atum	Dimensi	ion	Percer	ntage
Moderately packed	with some	e overla	apping		Bedroc	k	-			
Mostly a loose asso	rtment with	little ov	erlap		Boulder	r	>256mm		10	
No packing/loose as	sortment ea	asily mo	oved		Cobble		>64-256m	m	40	
Embeddedness:					Gravel		>2-64mm		35	
					Glaver					
(% gravel-boulder parti	cles covered	by fine s	sediment)		Sand		>0.06-2mm	n		
	1	by fine s 50%	sediment) 51-75%	>75%					10	
(% gravel-boulder parti	1		I I	>75%	Sand		>0.06-2mn	Smm	10 5	
(% gravel-boulder parti	% 26-	50%	I I	>75%	Sand Silt Clay	it typ	>0.06-2mn 0.004-0.06	Smm 1	5	
(% gravel-boulder parti <5% 5-25	% 26-{	50%	I I	>75%	Sand Silt Clay		>0.06-2mn 0.004-0.06 <0.004mm	Smm 1	5	
(% gravel-boulder parti <5% 5-25 Organic material	% 26-{	50%	I I	>75%	Sand Silt Clay Habita	ort)	>0.06-2mn 0.004-0.06 <0.004mm	omm Died	5	
(% gravel-boulder parti <5% 5-25 Organic material Large wood (>10cm <5% 5-25 Coarse detritus (sma	% 26-{ (% cover) diameter) % 26-{ all wood, sti	50%) 50% cks, lea	51-75% 51-75%	>75%	Sand Silt Clay Habita (% of eff Stones: Wood:	ort)	>0.06-2mn 0.004-0.06 <0.004mm es samp	omm	5	20%
(% gravel-boulder parti <5%	% 26-5 (% cover) diameter) % 26-5 all wood, sti % 26-5	50%) 50% cks, lea	51-75% 51-75%	>75%	Sand Silt Clay Habita (% of eff Stones: Wood: Macrop	ort)	>0.06-2mn 0.004-0.06 <0.004mm es samp 40% 5% 40%	oled	5	
(% gravel-boulder parti <5%	% 26-5 (% cover) diameter) % % 26-5 all wood, sti % % 26-5 c deposits	50%) 50% cks, lea 50%	51-75% 51-75% aves etc., >1mm 51-75%	>75%) >75%	Sand Silt Clay Habita (% of eff Stones: Wood: Macrop Edges:	ort) hyte:	>0.06-2mn 0.004-0.06 <0.004mm es samp 40% 5% 40% 15%	oled	5 ffles: uns:	
(% gravel-boulder parti <5%	% 26-5 (% cover) diameter) % % 26-5 all wood, sti % % 26-5 c deposits	50%) 50% cks, lea	51-75% 51-75%	>75%)	Sand Silt Clay Habita (% of eff Stones: Wood: Macrop Edges: Numbe	ort) hyte: r of in	>0.06-2mn 0.004-0.06 <0.004mm es samp 40% 5% 40% 15% vertebrate	n n n n n n n n n n n n n n n n n n n	5 ffles: uns: turned:	
(% gravel-boulder parti <5%	% 26-5 (% cover) diameter) % 26-5 all wood, sti % 26-5 c deposits % 26-5	50%) 50% cks, lea 50%	51-75% 51-75% aves etc., >1mm 51-75% 51-75%	>75%) >75%	Sand Silt Clay Habita (% of eff Stones: Wood: Macrop Edges:	ort) hyte: r of in	>0.06-2mn 0.004-0.06 <0.004mm es samp 40% 5% 40% 15% vertebrate	n n n n n n n n n n n n n n n n n n n	5 ffles: uns:	
(% gravel-boulder parti <5%	% 26-4 (% cover) diameter) % 26-4 all wood, sti % 26-4 c deposits % 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 36 36 % 36 36 % 36 36	50%) 50% 50% 50% eambe	51-75% 51-75% aves etc., >1mm 51-75% 51-75% d area)	>75%) >75%	Sand Silt Clay Habita (% of eff Stones: Wood: Macrop Edges: Numbe	ort) hyte: r of in Y	>0.06-2mn 0.004-0.06 <0.004mm es samp 40% 5% 40% 15% vertebrate	Died Ri Ri Ru es re Shrin	5 ffles: uns: turned:	20% 80%
(% gravel-boulder parti <5%	% 26-4 (% cover) diameter) % 26-4 all wood, sti % 26-4 c deposits % 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 26-5 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 26-5 36 % 36 36 % 36 36 % 36 36	50%) 50% cks, lea 50%	51-75% 51-75% aves etc., >1mm 51-75% 51-75%	>75%) >75%	Sand Silt Clay Habita (% of eff Stones: Wood: Macrop Edges: Numbe Koura: Crabs: Other:	ort) hyte: r of in Y N	>0.06-2mn 0.004-0.06 <0.004mm es samp 40% 5% 40% 15% vertebrate	Died Ri Ri Ru es re Shrin	5 ffles: uns: turned: nps: N	
(% gravel-boulder parti <5%	% 26-4 (% cover) diameter) % 26-4 all wood, sti % 26-4 c deposits % 26-5 DVer (% str & mats: % 26-5	50% 50% cks, lea 50% eambe	51-75% 51-75% aves etc., >1mm 51-75% 51-75% d area) 51-75%	>75%) >75% >75%	Sand Silt Clay Habita (% of eff Stones: Wood: Macrop Edges: Numbe Koura: Crabs: Other: Mussel	ort) hyte: r of in Y N type:	>0.06-2mn 0.004-0.06 <0.004mm es samp 40% 5% 40% 15% vertebrate	binnm bled Ri Ri Ru Shrin Muss	5 ffles: uns: turned: nps: N sels: N	80%
(% gravel-boulder parti <5%	% 26-4 (% cover) diameter) % 26-4 all wood, sti % 26-4 c deposits % 26-5 DVer (% str & mats: % 26-5	50%) 50% 50% 50% eambe	51-75% 51-75% aves etc., >1mm 51-75% 51-75% d area)	>75%) >75% >75%	Sand Silt Clay Habita (% of eff Stones: Wood: Macrop Edges: Numbe Koura: Crabs: Other:	ort) hyte: r of in Y N type:	>0.06-2mn 0.004-0.06 <0.004mm es samp 40% 5% 40% 15% vertebrate	binnm bled Ri Ri Ru Shrin Muss	5 ffles: uns: turned: nps: N	80%
(% gravel-boulder parti <5%	% 26-4 (% cover) diameter) % 26-4 all wood, sti % 26-4 c deposits % 26-4 DVer (% str & mats: % 26-4 000000000000000000000000000000000000	50% 50% cks, lea 50% eambe	51-75% 51-75% aves etc., >1mm 51-75% 51-75% d area) 51-75%	>75%) >75% >75%	Sand Silt Clay Habita (% of eff Stones: Wood: Macrop Edges: Numbe Koura: Crabs: Other: Mussel	ort) hyte: r of in Y N type:	>0.06-2mn 0.004-0.06 <0.004mm es samp 40% 5% 40% 15% vertebrate	binnm bled Ri Ri Ru Shrin Muss	5 ffles: uns: turned: nps: N sels: N	80%

Stream name: Waita	karurı	u Strea	am					9	Site n	umb	er: 12	231-5	4							
Sample number: 3				А	ssess	or: P	eter	Willia	ams				Date	: 14/	02/20	017				
Habitat parameter										Cate	gory									
		0	ptim	al			Sub	opti	mal			Μ	argin	al				Poor	ſ	
1. Riparian vegetative zone width	•	Banks buffer Contir	⁻ >10r	n		•	Bank vege <10m Most	tation			•	Pathy and/c Most	or sto	ck		•		ks fre ian ac ous	•	:
Left bank: 4	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 4	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 4																				
2. Vegetative protection	•	Bank s imme zones native Trees, shrub wood prese Veget disrup	diate cove vege unde s or n y plar nt ative	ripari red by station er-stor on- nts	/ n rey	•	cover nativ Disru Bank	s may red by	ainly etatio evide be	n nt	•	Bank cover of gra black & intr specie Veget disrup Bare cropp comm	ed by asses/ berry roduc es tation otion soil/c ped ve	y mixt /shrut , willo ed obvio losely	os, ow ous	•	cove & sh Disru strea vege high Gras graz Sign	s heav	y gras i of nk n very vily : stock	ĸ
Left bank:9	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:9	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 9			•	<u> </u>	<u> </u>		<u> </u>										<u> </u>	<u> </u>		-
3. Bank stability	•	Banks Erosic absen <5% c affect	on/ba t/mir of ban	nk fail iimal	ure	•	Infre areas	of er ly hea 6 of b	, sma osion Iled o	II	•	Mode unsta 30-60 reach erosid High poter flood	ble % of has a on erosio ntial d	bank areas	of	•	Man 60-1	able y eroc 00% c erosio	of ban	k
Left bank:15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 15																				
4. Frequency of riffles	•	Riffles freque Distar riffles strear Variet key	ent nce be divid n wid	etwee ed by th=5-	7	•	Dista riffle:	s infre	quen etwee led by	en v	•	Occas run Botto provie habita Distat riffles streat 25	m co de so at nce b divic	ntour me etwee led by	s en /	• •	wate riffle Poor Dista riffle	erally er, sha s habit ance b s divio am wio	illow at etwe ded b	y
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	•	Chang chann absen Strear patter	, iel/dr t/mir n wit	edgin imal		•	Evide chan Rece chan	nel/di ince c nel/di	edgir f past edgir	ig : ig	•	Chang chang exten Emba ing st prese banks 40-80	ges/di isive inkme ructu int on	ents/s res both reach	hor	• • •	gabi >809 reac or di Instr	ks shot on/ce % of st h char srupte ream h red/ab	ment ream nneliz ed nabita	ed

Habitat parameter			itego ptim			Ha	bitat	para	mete	r			itego ptim			На	bitat	para	mete	r
6. Sediment deposition	•	Little, point <20% affec sedin depo	bars of bo ted b nent	prese ottom /	nt	•	form from or fin 20-50 affec	ted t depo	most el, san iment botto	ly d t m	•	Some	e depo grave edim new 0% of ted nent o struct	osition I, sand ent or bars botto depos tions,	d or n m	•	fine r Incre deve	mater ased opmo of bo ging ently almo nt due nent	bar ent ottom ost e to	
Score: 17	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 velo regim Slow/ slow/ fast/s fast/o	nes pr /deep /shallo shallo	esent , ow,		•	regin If fas	tity/de nes pr t/shal ng the	esent low is		•	If fast slow/	ity/de nes pr t/shall (shalle	esent	r e	•	veloc regin	ity/de ne	d by 1 epth ep/slo	
Score: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	•	>50% favou inver colon variet debri mats Snags logs/f banks provi fish c Must trans	irable tebra isatic ty of v s, riff s/ sub under s/cob des a over not b	for te wood les, ro merg cut bles bunda	ed ant	•	favou inver color Snags logs/ banks Fish o Mode of ha Can o	0% sul urable tebra hisatic s/ sub under s/cob cover erate bitat consis mater	for te on omerg cut bles comn variet types t of so	ed non sy	•	favou inver colon Fish c 60-90	irable tebra isatic over 0% su v mov dy de ay be herec	te patch bstrat ed by bris ra	γ e	•	abser Subst or lac Stabl	urable tebra iisatic cover nt trate cking e hab ng or	e for te on rare o unsta itats limite	ble
Score: 12	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	•	Perip evide held s (mac wood sedin	nt on subst rophy l etc.,	hand rates rtes,		•	visibl subst	hytor e on trates ous to	but	ı	•	<20%	cove	n visib er of ubstra		•	& pro	, olific 5 cove	n obvi er of ubstra	
Score: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 125																				

Stream name: Piakon	ui Stream				Assesso	or: Kath	ryn Reeve			
Site number: 765-15		Samp	le number: 8		Date: 2	1/02/2	017 1	Гime	: 12:30	
GPS coordinates		Down	nstream:		E 18312	220	1	N 580	09988	
		Upstr	eam:							
Channel & riparian	features				Instrea	am hyo	draulic co	ndit	ions	
Canopy cover:					Estimate	d or me	asured reac	h ave	rage:	
Open	Partly s	haded	Very sl	haded						
Fencing:	Dominant	ripariar	n vegetation:		Stream	width	(active cha	nnel):	
None/ineffective	Crops		Retired veg	etation	Stream	width	(water): 4 ı	m		
One side/partial	Pasture		Native shru	ıb	Stream	depth:				
Complete	Exotic tree	S	Native tree	S	Surface	velocit	iy:			
Water quality										
Temperature:	16.6		°C		Conduc	tivity:	7	72.2	μS	cm ⁻¹
Dissolved oxygen:	87.1		%		8.48		r	ng l ^{-:}	1	
Turbidity:	Clear		Slightly turbid	Highly t	urbid	Stair	ied		Other	
Stream-bottom sub	ostrata									
Compaction (inorgan	ic substrata):	1			% surfic		rganic sub	strat	um size	
Assorted sizes tightly	packed &/or	r overla	pping		Substra	tum	Dimensio	on	Percent	tage
Moderately packed w	ith some ove	rlappin	g		Bedroc	<	-			
Mostly a loose assort	nent with litt	le over	lap		Boulder		>256mm		50	
No packing/loose asso	ortment easily	y move	d		Cobble		>64-256mm	n	25	
Embeddedness:					Gravel		>2-64mm		10	
(% gravel-boulder particl	es covered by f	ine sedir	ment)		Sand		>0.06-2mm		5	
<5% 5-25	% 26-5	50%	51-75%	>75%	Silt		0.004-0.06n	nm	10	
•	•				Clay		<0.004mm			
Organic material (%	် cover)				Habita	t type	s sampled	d	•	
Large wood (>10cm d	iameter)				(% of eff	ort)				
<5% 5-25	% 26-5	50%	51-75%	>75%	Stones:		80%			
	wood, sticks	, leaves	s etc., >1mm)		Wood:		10%	Ri	ffles:	65
Coarse detritus (small	1	50%	51-75%	>75%	Macrop	hyte:	%	Ru	ins:	35
Coarse detritus (small	% 26-5						10%			
<5% 5-25	I				Edges:				rned	
1	deposits	50%	51-75%	>75%		r of inv	ertebrates	retu	incu.	
<5% 5-25 Fine (<1mm) organic (<5% 5-25	deposits % 26-5	50%		>75%			ertebrates		nps: N	
<5% 5-25 Fine (<1mm) organic (<5% 5-25 Instream plant cov	deposits % 26-5 er (% stream)	50%		>75%	Numbe	Y	ertebrates	Shrin		
<5% 5-25 Fine (<1mm) organic (<5% 5-25 Instream plant cov	deposits % 26-5 er (% stream nats:	50%		>75%	Numbe Koura: '	Y	ertebrates	Shrin	nps: N	
<5% 5-25 Fine (<1mm) organic (<5% 5-25 Instream plant cov Filamentous algae & r	deposits % 26-5 er (% stream nats:	50% bed are	ea)		Numbe Koura: ' Crabs: I	YN	ertebrates	Shrin	nps: N	
<5% 5-25 Fine (<1mm) organic (<5% 5-25 Instream plant cov Filamentous algae & r <5% 5-25	deposits % 26-5 er (% stream nats: % 26-5	50% bed are	ea)		Numbe Koura: ` Crabs: I Other:	Y N type:	ertebrates S	Shrin Muss	nps: N	
<5% 5-25 Fine (<1mm) organic (<5% 5-25 Instream plant cov Filamentous algae & r <5% 5-25 Macrophytes:	deposits % 26-5 er (% stream nats: % 26-5	50% bed are	51-75%	>75%	Numbe Koura: Crabs: I Other: Mussel	Y N type:	ertebrates S	Shrin Muss	nps: N sels: N	

Wadeable Hard-Bo Qualitative Habitat As					Shee	et														
Stream name: Piakon	ui Str	eam						9	Site n	umb	er: 7!	53-15	5							
Sample number: 8				A	ssess	or: K	athry	n Re	eve				Date	: 21/	02/2	017				
Habitat parameter	·	C	ptim	al			Sub	ooptii	mal	Cate	gory		argir	nal				Poo	r	
1. Riparian vegetative zone width	•	>10n	tatior n inuou	n buffe is &	er	•	Bank veget <10m Most	tation 1			•		or sto			•	Hun	aks fre nan ac ious	•	:
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	•	imme zone nativ Trees shrul wood prese Vege	ediate s cove e veg s, und os or i dy pla ent tative	nts	ian y n orey	• • •	nativ Disru Bank	red m e vege ption s may red by	ainly etatio evide be	n ent	•	cover of gra black & int speci Vege disru Bare	asses/ berry roduc es tatior ption soil/c ped ve	/ mixt /shrut , willo :ed	os, ow ous	•	cove & sh Disr stre vege high Graa graa Sign	ss hea	y gras n of nk n very vily t stock	¢
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	•	Erosi failur abse	nt/mi of bai	ank nimal		•	Infree areas	of er ly hea 6 of b	, sma osion iled o	II	•	unsta 30-60 reach erosi High	0% of has a on erosio htial c	bank areas	of	•	Mai 60-:	table ny eron 100% c erosio	of ban	k
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	•	frequ Dista riffle strea	ient nce b s divio m wio	tively etwee ded by dth=5 habita	en / -7	•	Dista riffles	s infre	equen etwee led by	en /	•	provi habit Dista riffles	om co de so at nce b s divio	ntour	s en /	•	wat riffl Poo Dist riffl	erally er, sha es r habit ance k es divi am wi	allow tat betwee ded by	y
Score: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	•	chan abse Strea		redgir nimal th	ng	•	chan Evide chan Recei chan	nel/dr	redgir of past redgir	ng : ng	•	exter Emba ing st prese bank 40-80 Chan	ges/d nsive ankme cructu ent on s 0% of nelize	i both reach	hor	•	gab >80 read or d Inst	ks sho ion/ce % of st ch chai isrupt ream l red/at	ment tream nneliz ed nabita	ed
Score: 20	20	19	18	17	16	15	14	13	12	11	10	disru 9	ptea 8	7	6	5	4	3	2	1
			1			<u> </u>	1	· · ·										-	1	1

		Ca	itego	ory		Ha	bitat	para	mete	r		Ca	itego	ory		Ha	bitat	para	mete	er
Habitat parameter		0	ptim	al								0	ptim	al						
6. Sediment deposition	•	Little, point <20% affec sedin depo	bars of bo ted by nent	prese ottom /	nt	•	form from or fin 20-50 affec	ation, grave le sed 0% of ted t depo	ase in most I, san iment botto ositior	ly d t m	•	Some new (fine s old & 50-80 affec Sedin at ob const bend	gravel edim new 0% of ted nent o struct	l, sand ent of bars botto depos tions,	d or n vm	•	fine i Incre deve >80% chan frequ Pools abse sedir	ased lopm of b ging uently s almont due	bar ent ottom ost e to	
Score: 16	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 velo regim Slow/ slow/ fast/s fast/o	nes pr /deep /shallo shallo	esent , ow,		•	regin If fas	tity/de nes pr t/shal	esent		•	2 of 4 veloc regim If fast slow/ missi	ity/de nes pr t/shal (shallo	esent low o ow ar	r e	•	veloo regin	ity/d ne	d by 1 epth ep/slo	
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% favou inver colon variet debri mats Snage logs/ banks provi fish c Must trans	irable tebra isatic ty of v s, riff s/ sub under s/cob des a over not b	for te wood les, ro merg cut bles bunda	ed ant	•	favou inver color Snag logs/ bank Fish o Mode of ha Can o	urable tebra nisatic s/ sub under s/cob cover erate bitat	te omerg cut bles comn variet types. t of so	ed non sy	•	10-30 favou inver color Fish o 60-90 easily foot Wood or ma smot sedin	irable tebra isatio cover 0% sul v mov dy del ay be hered	for te on patch bstrat ed by bris ra	iy ce	•	favor inver color Fish abse Subs or lac Stabl lackin	urable tebra nisatio cover nt trate cking e hat	te on rare o unsta iitats limite	ble
Score: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	•	Perip evide held s (mac wood sedin	nt on subst rophy l etc.,	hand rates rtes,) or fi		•	visibl subst	rates		ı	•	Perip <20% availa	cove	r of		•	& pro	olific 5 cove	n obvi er of ubstra	
Score: 20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 163					•		•	•	•	•	•	•		•		•				

Stream name: Paiaka	ahi Stream D	/S			Assesso	or: Pete	r Williams			
Site number: 718-5		Samp	le number: 1		Date: 1	3/02/2	017	Tim	e: 09:45	
GPS coordinates		Dowr	nstream:		E18410	27	I	N58	67879	
		Upstr	ream:		E18410	98		N58	67799	
Channel & riparian	features				Instrea	am hy	draulic co	ndi	itions	
Canopy cover:							asured read			
Open	Partly s	haded	Very s	shaded						
Fencing:	Dominant	riparia	n vegetation:		Stream	width	(active cha	nne	el):	
None/ineffective	Crops		Retired ve	getation	Stream	width	(water): 3.	9m		
One side/partial	Pasture		Native shr	ub	Stream	depth:	0.30m			
Complete	Exotic tree	s	Native tree	es	Surface	veloci	ty: <1 m/s			
Water quality	a									
Temperature:	18.5		°C		Conduc	tivity:		124	.4 μS	cm ⁻¹
Dissolved oxygen:	96.7		%		9.06			mg	-1	
Turbidity:	Clear		Slightly turbid	Highly t	urbid	Stair	ned		Other	
Stream-bottom sul	ostrata									
Compaction (inorgan	ic substrata):				% surfic		rganic sub	stra	ıtum size	
Assorted sizes tightly	packed &/or	overla	opping		Substra		Dimensi	on	Percen	tage
Moderately packed w	-				Bedroc		-	-		
Mostly a loose assort			-		Boulder		>256mm		40	
No packing/loose asso	ortment easily	y move	d		Cobble		>64-256mr	n	50	
Embeddedness:					Gravel		>2-64mm		9	
(% gravel-boulder particl	es covered by f	ine sedi	ment)		Sand		>0.06-2mm	1	1	
<5% 5-25	% 26-5	50%	51-75%	>75%	Silt		0.004-0.06	mm		
					Clay		<0.004mm			
Organic material (%	6 cover)				Habita	t type	s sample	d	•	
Large wood (>10cm d	iameter)				(% of eff	ort)				
<5% 5-25	% 26-5	50%	51-75%	>75%	Stones:		92%			
Coarse detritus (small	wood, sticks	, leaves	s etc., >1mm)		Wood:		%	F	liffles:	71%
<5% 5-25	% 26-5	50%	51-75%	>75%	Macrop	hyte:	%	F	luns:	29%
Fine (<1mm) organic	deposits				Edges:		8%			
<5% 5-25	% 26-5	50%	51-75%	>75%	Numbe	r of inv	ertebrates	s ret	urned:	
Instream plant cov	er (% stream	bed are	ea)		Koura:	Y		Shri	mps: N	
Filamentous algae & r	nats:				Crabs: I	N		Mus	sels: N	
<5% 5-25	% 26-5	50%	51-75%	>75%	Other:	N				
Macrophytes:					Mussel	type:				
< 5% 5-25	% 26-5	50%	51-75%	>75%	Hyridel	la		Cuc	umerunio	
Mosses/liverworts:										
<5% 5-25	% 26-5	50%	51-75%	>75%						

Stream name: Paiakara	ahi S	trean	ו D/S					5	Site n	umb	er: 7:	18-5								
Sample number: 1				A	ssess	or: P	eter	Willia	ams				Date	: 13/	02/2	017				
Habitat parameter		С	ptim	al			Sub	ooptii	mal	Cate	gory		argin	ial				Роог		
1. Riparian vegetative zone width	•	>10n	tatior n inuou	ı buffe s &	er	•	Bank	side tation	buffe		•	Pathv and/c Most	ways p or sto	oresei ck		•		ks fre an ac ous	•	
Left bank: 20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 19.5																				
2. Vegetative protection	•	imme zone nativ Trees shrul wood prese Vege	ediate s cove e veg s, und os or dy pla ent tative	nts	ian y n orey	•		red m e vege ption s may red by	ainly etatio evide be	n ent	•	Bank cover of gra black & intr specie Veget disrup Bare cropp comn	red by asses/ berry, roduc es tation ption soil/cl ped ve	y mixt /shrut , willo ed obvio losely	os, ow ous	•	cove & sh Disru strea vege high Gras graze Signi	uption um ba tatior s heav	y gras: of nk i very vily stock	¢
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: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
3. Bank stability	•	Erosi failur abse	nt/mi of bai	ank nimal		•	Infree areas	of er ly hea 6 of b	, sma osion iled o	II	•	Mode unsta 30-60 reach erosid High poter flood	ible)% of i has a on erosic ntial d	bank areas	of	•	60-1	able y eroc 00% c erosio	f ban	k
Left bank: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 11	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	•	frequ Dista riffle strea	ient nce b s divio m wio	tively etwee led by dth=5 habita	en / -7	• •	Dista riffles	s infre	quen etwee led by	en /	•	Occas run Botto provie habita Distar riffles streat 25	om con de son at nce bo s divid	ntour me etwee led by	s en /	•	wate riffle Poor Dista riffle	erally sr, sha habit ince b s divio im wio	llow at etwee ded by	y
Score: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	•	chan abse Strea		redgir nimal th	0	•	Evide chan Rece chan	nel/dr nce o nel/dr	edgir f past edgir	ng : ng	•	Chang chang exten Emba ing st prese banks 40-80	ges/di isive inkme ructu ent on	ents/s res both	hor	•	gabio >80% react or di Instr	s sho on/ce on/ce of st char srupte eam h ed/ab	ment ream nelize ed abita	ed

Habitat parameter			itego ptim			Ha	bitat	para	mete	r			atego ptim			Ha	bitat	para	mete	r
6. Sediment deposition	•	Little, point	/no is bars of bo ted by nent	lands prese ottom /	nt	•	form from or fin 20-50 affec	ted t depo	most el, san iment botto	ly d t m	•	Some new (fine s old & 50-80 affec Sedin at ob	e depo grave edim new 0% of ted nent o struct	osition I, sand ent or bars botto depos tions,	d or n m	•	fine r Incre deve >80% chan frequ Pools abset sedin	mater ased lopm of be ging lently s almo nt due	bar ent ottom ost e to	
Score: 18	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Velocity/depth regimes	•		nes pr /deep /shallo shallo	ow,		•	regin If fas	tity/de nes pr t/shal ng the	esent low is		•	If fas slow/	ity/de nes pr t/shall (shalle	esent	r e	•	veloc regin	ity/d ne	d by 1 epth ep/slo	
Score: 17	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	•	variet debri mats Snags logs/ banks provi fish c	irable tebra isatic ty of v s, riff s/ sub under s/cob des a over not b	for te on & w woody les, ro merge cut	ed ant	•	favou inver color Snag logs/ bank Fish o Mode of ha Can o	0% sul urable tebra hisatic s/ sub under s/cob cover erate bitat consis mater	for te on omerg cut bles comn variet types t of so	ed non sy	•	favou inver color Fish o 60-90	urable tebra hisatic cover 0% su y mov dy de ay be herec	te patch bstrat ed by bris ra	γ e	•	favou inver color Fish o abset or lao Stabl lackin	nt trate cking e hab	e for te on rare o unsta itats limite	ble
Score: 16	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	•	held : (mac	nt on subst rophy l etc.,	hand rates		•	visibl subst	hytor e on trates ous to	but	ı	•	<20%	cove	n visib er of ubstra		•	& pro	, olific 6 cove	n obvi er of ubstra	
Score: 6	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 144.5																				

Stream name: Karen	gorengo Strea	am				Assess	or: Ka	thryn Ree	eve	
Site number: 232-3	5	Sample	e number: 9			Date: 2	1/02/2	2017	Time	: 15:20
GPS coordinates	[Downst	tream:			E 1848	393		N 58	23235
	ι	Jpstrea	am:			E 1848	423		N 58	23069
Channel & riparia	n features					Instre	am h	ydraulic	; cor	nditions
Canopy cover:						Estimate	ed or m	easured re	each a	verage:
Open	Partly sha	Ided	Very	shad	ded					
Fencing:	Dominant rij	parian	vegetation:			Stream	width	(active c	hann	el): 2.9 m
None/ineffective	Crops		Retired v	veget	tation	Stream	width	(water):	1.5 m	ı
One side/partial	Pasture		Native sl	hrub		Stream	depth	n: 0.37m		
Complete	Exotic trees	s	Native tr	ees		Surface	e veloo	city: m s ⁻¹		
Water quality										
Temperature:	19.0		°C			Conduc	ctivity:		191.4	1 μS cm ⁻¹
Dissolved oxygen:	85.4		%			7.92	1		mg l ⁻	1
Turbidity:	Clear	Ş	Slightly turbi	id	Highly t	urbid	Stai	ned	(Other
Stream-bottom se		a):				% surf compo			sub	stratum size
Assorted sizes tightly	•					Substra	atum	Dimens	sion	Percentage
Moderately packed v			-			Bedroc		-		
Mostly a loose assor			•			Boulde		>256mm		
No packing/loose a	ssortment ea	isily m	noved			Cobble		>64-256m		
Embeddedness:		c	r ()			Gravel		>2-64mm		10
(% gravel-boulder partic	1	1			750/	Sand		>0.06-2m		80
<5% 5-25%	6 26-509	%	51-75%	>	75%	Silt Clay		0.004-0.00 <0.004mn		10
Organic material	(% cover)					Habita	it typ	es sam	pled	
Large wood (>10cm						(% of eff				
		%	51-75%	>	75%	Stones		%	5	
<5% 5-25%			ا es etc., >1m	nm)		Wood:		5%	Ri	ffles: %
<5% 5-25% Coarse detritus (sma	II wood, sticks	s, leav							δ Rι	uns: 100%
			51-75%	>	75%	Macrop	hyte:	95%		
Coarse detritus (sma	6 26-509		51-75%	>	75%	Macrop Edges:	hyte:	95% %		
Coarse detritus (sma	6 26-50 deposits	%	51-75%	l Ì	75% 75%	Edges:			, D	turned:
Coarse detritus (sma <5% 5-25% Fine (<1mm) organic	6 26-509 deposits 6 26-509	%	51-75%	l Ì		Edges:	r of in	% vertebrate	es ret	turned: nps: N
Coarse detritus (sma <5%	6 26-50 6 deposits 6 26-50 7 over (% strea	%	51-75%	l Ì		Edges: Numbe	r of in Y	% vertebrate	es ret Shrin	
Coarse detritus (sma <5%	6 26-50 6 deposits 6 26-50 7 ver (% strea mats:	%	51-75%	>		Edges: Numbe Koura:	r of in Y	% vertebrate	es ret Shrin	nps: N
Coarse detritus (sma <5% 5-25% Fine (<1mm) organic <5% 5-25% Instream plant co Filamentous algae &	6 26-50 6 deposits 6 26-50 7 ver (% strea mats:	%	51-75% area)	>	75%	Edges: Numbe Koura: Crabs:	r of in Y N	% vertebrate	es ret Shrin	nps: N
Coarse detritus (sma <5%	6 26-50 6 deposits 6 26-50 7 over (% strea mats: 6 26-50 1	% % mbed =	51-75% area)	>	75%	Edges: Numbe Koura: Crabs: Other:	r of in Y N type:	% vertebrate	s rei Shrin Muss	nps: N
Coarse detritus (sma <5%	% 26-50° c deposits 26-50° % 26-50° over (% streating the streat	% % mbed =	51-75% area) 51-75%	>	75% 75%	Edges: Numbe Koura: Crabs: Other: Mussel	r of in Y N type:	% vertebrate	s rei Shrin Muss	nps: N sels: N

Wadeable Soft-Bott Qualitative Habitat Ass					o Sh	oot														
Stream name: Karengo					a Sh	eet			Site n	umb	or: 23))))								
Sample number: 9	Jieng	30 30	ean	-		ork	athr	/n Re		unib	er. 23		Data	: 21/	02/2	017				
Sample number: 9				A	ssess		atriry	/п ке	eve	Cat			Date	. 21/	02/2	017				
Habitat parameter		~		1						Cate	egory			- 1				D		
			ptim					oopti	mai				argin					Poor		
1. Riparian vegetative zone width	•	Bank vege >10n	tatio	n buf	fer	•	Bank vege <10n	tation	buffe	er is	•	Pathy and/o Most	or sto	ck		•		ks freo an act ous	•	
	•	Cont dens		us &		•	Most	tly cor	ntinuo	us									1	
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																				
2. Vegetative protection	•	imm ripar cove vege Tree store	ediat ian z red t tatio s, un ey sh woo ent etativ uptio	ones by nat n der- rubs o dy pla	ive or	•	cove nativ Disru Bank	e veg option s may red by	ainly l etatio evide	n nt	•	Bank cover of gra black & intr speci Vege disru Bare cropp comn	red by asses/ berry, roduc es tation otion soil/cl ped ve	v mixt /shrub ed obvio losely	us	•	cove & shi Disru strea vege high Grass graze Signi	iption m bai tation s heav	of nk very vily stock	
Left bank: 9	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 9	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 9																				
3. Bank stability	•	Bank Erosi failur abse <5% affec	ion/t re nt/m of ba	oank ninima	al	•	Infre areas most	quent s of er :ly hea % of b	y stab , smal rosion aled or ank	II	•	Mode unsta 30-60 reach erosid High poter flood	ble % of has a on erosic ntial d	bank areas	of	•	60-10	able y eroc 20% o erosio	f banl	k
Left bank: 13	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank: 13	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 13			<u> </u>															1		1
4. Channel sinuosity	•	strea time	am le s Ion	rease ngth ger th traigh	3-4 nan	•	strea times		gth 2- er tha		•	Bend strea times it was	m len long	gth 1- er tha		•	Chan	nel st	raight	t
Score: 10	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	•	abse Strea	nel/o nt/m am w	dredg ninima	al	•	chan Evide chan Rece chan	nel/di ence c nel/di nt	nges to redgin f past redgin redgin nt	lg Ig	•	Chan chang exter Emba ing st prese banks 40-80 chan disru	ges/di isive inkme ructu int on s 1% of nelize	ents/s res both reach	hor	•	gabio >80% reach or dis Instru	s shor on/cer 6 of st n char srupte eam h ed/ab	ment ream inelize ed abitat	ed
Score:19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

		Ca	itego	ory		Ha	bitat	para	mete	r		Cá	atego	ory		Ha	bitat	par	amet	er
Habitat parameter		0	ptim	al								0	ptim	al						
6. Sediment deposition	•	•	bars of bo ted b nent	prese ottom y	nt	•	form from or fin 20-50 affec	ation, grave le sed D% of ted t depo	ase in most l, san iment botto ositior	ly d t m	•	new fine s old & 50-80 affec Sedir at ob	nent struc trictio	l, sand ent of bars botto depos tions,	d or n m	•	fine Incre deve >809 chan frequ Pool	mate ease lopr 6 of ging uent s aln nt d men	d bar nent bottor ly nost ue to t	
Score: 14	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Pool variability	•	Pools Large large small small	/shal /deep /shal	o, low,	ked	•	large	, deep few s	f pool o hallov		•		alence ow po			•			of poo allow	ols
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	•	varie debri mats Snag logs/ bank provi fish c	irable tebra isatic ty of s, riff s/ sub under s/cob des a over not b	e for te on & v wood les, rc omerg rcut	y oot ed	•	favou inver color Snag logs/ bank Fish o Mode of ha Can o	urable tebra hisatic s/ sub under s/cob cover erate bitat	te omerg rcut bles comn variet types. t of so	ed non Sy	•	favou inver color Fish o 60-90 easily foot Woo or ma	D% su urable tebra hisatic cover D% su y mov dy de ay be herec nent	for te on patch bstrat ed by bris ra	y e	•	favo inve colo Fish abse Subs or la Stab	urab rtebi nisat cove nt trate cking le ha ng o	ion er rare e unsta g abitats r limit	or able
Score: 12	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	•	held Stabl	nt on stone e sub ces ro	hand	!	•	visibl Stabl	e sub hytor	n not stones strate n obvi		•	<20%	bytor cove able s	r of		•	& pr >20%	olific 6 cov	on obv c ver of subst	
Score: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 127	•		. <u> </u>		•				•		•									

Stream name: Wairer	e Stream				Assesso	r: Pete	r Williams			
Site number: 1224-5		Samp	le number: 5		Date: 1	5/02/2	017	Time	e: 14:30	
GPS coordinates		Dowr	nstream:		E 27421	.84		N 63	65455	
		Upstr	ream:		E 27420	94		N 63	65394	
Channel & riparian	features				Instrea	m hyo	draulic co	ondit	tions	
Canopy cover:					Estimate	d or me	asured read	h ave	erage:	
Open	Partly s	haded	Very sh	aded						
Fencing:	Dominant	riparia	n vegetation:		Stream	width	(active cha	nnel	l):	
None/ineffective	Crops		Retired vege	etation	Stream	width	(water): 5.	7m		
One side/partial	Pasture		Native shru	b	Stream	depth:	0.3m			
Complete	Exotic tree	es	Native trees	5	Surface	velocit	:y: 1-2 m/s	5		
Water quality										
Temperature:	16.6		°C		Conduc	tivity:		64.9	μS	cm ⁻¹
Dissolved oxygen:	89.2		%		8.69			mg l ⁻	1	
Turbidity:	Clear		Slightly turbid	Highly t	urbid	Stair	ned		Other	
Stream-bottom sul	ostrata									
Compaction (inorgan	ic substrata):	:			% surfic compos		rganic sub	stra	tum size	
Assorted sizes tightly	packed &/or	overlap	pping		Substra	tum	Dimensi	on	Percent	tage
Moderately packed w	ith some ove	rlappin	g		Bedrock	:	-			
Mostly a loose assort	ment with lit	tle ove	erlap		Boulder		>256mm		2	
No packing/loose asso	ortment easily	y move	d		Cobble		>64-256mr	n	65	
Embeddedness:					Gravel		>2-64mm		25	
(% gravel-boulder particl	es covered by f	ine sedi	ment)		Sand		>0.06-2mm	ı	7	
<5% 5-25	% 26-5	50%	51-75%	>75%	Silt		0.004-0.06	mm	1	
					Clay		<0.004mm			
Organic material (%	6 cover)				Habita	t type	s sample	d		
Large wood (>10cm d	iameter)				(% of eff	ort)				
< 5% 5-25	% 26-5	50%	51-75%	>75%	Stones:		90%	>		
Coarse detritus (small	wood, sticks	, leaves	s etc., >1mm)		Wood:		%	Ri	iffles:	50%
<5% 5-25	% 26-5	50%	51-75%	>75%	Macrop	hyte:	%	R	uns:	40%
Fine (<1mm) organic	deposits				Edges:		10%			
<5% 5-25	% 26-5	50%	51-75%	>75%	Numbe	r of inv	ertebrates			
	er (% stream	bed are	ea)		Koura: \	(Shrir	nps: Y	
Instream plant cov	mats:				Crabs: N	1		Mus	sels: N	
Instream plant cov Filamentous algae & r		C 00/	51-75%	>75%	Other:					
-	% 26-5	50%			Mussel	type:	1			
Filamentous algae & r <5% 5-25 Macrophytes:	I I		1 1							
Filamentous algae & r <5%	I I	50%	51-75%	>75%	Hyridell			Сиси	merunio	
<5% 5-25 Macrophytes:	% 26-5		51-75%	>75%				Сиси	merunio	

Stream name: Wairer	e stre	am						9	Site n	umb	er: 12	224-5	,								
Sample number: 5				А	ssess	or: P	eter	Willia	ams				Date	: 15/	02/2	017					
Habitat parameter		(Optim	al			Sub	oopti	mal	Cate	gory		argin	al				Роог	ſ		
1. Riparian vegetative zone width	•	vege >10r	inuou		er	•	<10n	tation			•	Pathv and/c Most	or sto	ck		•		aks fre nan ac ous	•		
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: 20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
Mean: 15.5																					
2. Vegetative protection	•	imm zone nativ Tree shru woo pres Vege	s surfa ediate s cove ve veg s, und bs or i dy pla ent etative iption	e ripar ered b etatio er-sto non- nts	ian y n orey	•	cover nativ Disru Bank	surfa red m e veg ption s may red by try	ainly etatio evide be	n ent	•	Bank cover of gra black & intr specie Veget disrup Bare cropp comm	red by asses/ berry, roduc es tation ption soil/cl ped ve	y mixt /shrub , willo ed obvio losely	us	•	cove & sh Disru strea vege high Gras graz Sign	ered b irubs uption am ba etation es heav ed ificant	y gras i of nk i very vily : stock	¢	
Left bank: 6	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	
3. Bank stability	•	Eros failu abse	nt/mi of bar	ank nimal		•	Infre areas most	eratel quent s of er ly hea % of b ed	, sma osion iled o	II	•	Mode unsta 30-60 reach erosid High poter flood	ible)% of i has a on erosic ntial d	bank areas	of	•	5 4 3 2 • Bank surfaces covered by grass & shrubs • • Disruption of stream bank vegetation very high • • Grass heavily grazed • • Significant stock damage to bank 5 4 3 2 4 3 • Unstable • Many eroded ar • 60-100% of banl has erosional sci 5 4 3 2 4 3 5 4 3 6 3 2 • Generally flat water, shallow riffles • Poor habitat				
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: 18	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
Mean: 16.5																				_	
4. Frequency of riffles	•	freq Dista riffle strea	es rela uent ance b s divic am wic ety of	etwee led by dth=5	en / -7		Dista riffle:	s infre	equen etwee led by	en /	•	Occas run Botto provie habita Distan riffles strean 25	om con de son at nce bo s divid	ntour me etwee led by	s en	•	wate riffle Poor Dista riffle	er, sha es r habit ance b es divid	illow at etwei ded by	y	
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	•	char abse Strea	nges to inel/di int/mi am wit nal pa	redgir nimal th	-	•	chan Evide chan Rece chan	e char nel/di ence c nel/di nt nel/di oresen	redgir of past redgir	ng : ng	•	Chang chang exten Emba ing st prese banks 40-80 chan	ges/di isive inkme ructu ent on 5 0% of	ents/s res both reach	hor	•	gabi >809 reac or d Instr	ks sho on/ce % of st h chai isrupto ream h red/at	ment ream nneliz ed nabita	ed	

Habitat parameter		Ca	atego	ory		Ha	bitat	para	mete	er		Ca	atego	ory		Ha	bitat	para	mete	er
Habitat parameter		0	ptim	al								0	ptim	al						
6. Sediment deposition	•	point	bars of bo ted b nent		ent	•	form from or fin 20-50 affec	t depo	most el, san iment botto	t d t	•	new fine s old & 50-80 affec Sedin at ob	nent o struct	l, sand ent of bars botto depos tions,	d or n vm	•	fine Incre deve >809 char freq Pool abse sedi	mate eased elopm	bar ent ottom / ost e to	
Score: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Velocity/depth regimes	•		nes pr /deep /shallo shallo	ow,		•	regin If fas	ity/de nes pr t/shal ng the	esent low is	5	•	regin If fas slow,	ity/de nes pr t/shal (shalle ng, sc	esent low o ow ar	r e	•	velo regii	city/d ne	d by 1 epth eep/sle	
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	•	favou inver color varie debri mats Snags logs/ banks provi fish c	urable tebra isatic ty of s, riff s/ sub unde s/cob des a over not b	ite on & v wood iles, ro omerg rcut	y bot ged ant	•	favou inver color Snags logs/ bank Fish o Mode of ha Can o	0% sul irable tebra iisatio s/ sub under s/cob cover erate bitat consis mater	e for te on omerg cut bles comn variet types t of so	ed non ty	•	favou inver color Fish o 60-90 easily foot Wood or ma	, ay be herec	for te on patch bstrat ed by bris ra	iy ce	•	favo inve colo Fish abse Subs or la Stab lacki	urabl rtebra nisati cover ent strate cking le hal	ate on rare o unsta bitats limite	ble
Score: 11	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	•	held Stabl	ent or stone e sub ces re	n hand	2	•	visibl Stabl	hytor e on s e sub: hytor uch	stone: strate	•	•	<20%	hytor cove able s	r of		•	Peri & pr >209 avai			
Score: 2	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE 124		•																		

Stream name: Waite	ariki stream	<u>ا</u>			Assess	or: Ka	thryn Ree	ve		
Site number: 1430-1	0	Sam	ple number: 1	0	Date: 2	2/02/2	2017 T	ime:	12:15	
GPS coordinates		Dow	nstream:		E 1852	566	١	1 581	18150	
		Upst	ream:		E 1852	697	١	1 581	8212	
Channel & riparia	an feature:	s			Instre	am h	ydraulic	con	ditions	
Canopy cover:					Estimate	ed or m	easured rea	ach a'	verage:	
Open	Partly s	hadeo	d Very	shaded						
Fencing:	Dominant	riparia	an vegetation:		Stream	width	(active ch	anne	el):	
None/ineffective	Crops		Retired v	egetation	Stream	width	(water): 7	.9 m		
One side/partial	Pasture		Native sl	hrub	Stream	depth	n:			
Complete	Exotic tree	es	Native to	rees	Surface	e veloo	city:			
Water quality										
Temperature:	14.2		°C		Condu	ctivity:	3	8.3	μS	cm ⁻
Dissolved oxygen:	102.2		%		10.46		n	ng l ⁻¹		
Turbidity:	Clear		Slightly turbi	id Highly	turbid	Stai	ned	C	Other	
Stream-bottom s	ubstrata									
Compaction (inorg	anic substr	ata):			% surf compo		norganic : i:	subs	stratum	size
Assorted sizes tigh	tly packed	&/or	overlapping		Substra	atum	Dimensi	on	Percen	itage
Moderately packed	vith some o	verlap	ping		Bedroc	k	-			
Mostly a loose asso	tment with I	ittle ov	verlap		Boulde	r	>256mm		50	
No packing/loose as	sortment ea	isily m	oved		Cobble		>64-256mm	n	30	
Embeddedness:					Gravel		>2-64mm		20	
(% gravel-boulder partie	cles covered b	oy fine	sediment)		Sand		>0.06-2mm	ı –		
<5% 5-259	% 26-5	50%	51-75%	>75%	Silt		0.004-0.06	mm		
					Clay		<0.004mm			
Organic material	(% cover))			Habita	at typ	es samp	led		
Large wood (>10cm	diameter)				(% of ef	fort)				
<5% 5-259	% 26-5	50%	51-75%	>75%	Stones	:	80%			
Coarse detritus (sma	all wood, stic	cks, le	aves etc., >1m	nm)	Wood:		%	Rif	fles:	80%
<5% 5-259	% 26-5	50%	51-75%	>75%	Macrop	ohyte:	%	Ru	ins:	20%
Fine (<1mm) organic			1 1		Edges:		20%			
<5% 5-259	% 26-5	50%	51-75%	>75%	Numbe	er of in	vertebrate	s ret	urned:	
Instream plant co	over (% stre	eambe	ed area)		Koura:	Y	S	Shrim	ips: Y	
Filamentous algae 8	mats:				Crabs:	Ν	Ν	/luss	els: N	
Thanientous algae o	% 26-5	50%	51-75%	>75%	Other:					
<5% 5-25%			ı ,		Musse	•••				
<5% 5-25° Macrophytes:			51-75%	>75%	Hyride	lla	0	Cucu	merunio	
<5% 5-25% Macrophytes: <5% 5-25%	% 26-5	50%	51-7576							
<5% 5-25° Macrophytes:	I I		51-75%	>75%						

Stream name: Waite	earik	i Str	eam					5	Site r	numt	ber:	1430	-10									
Sample number: 10				Α	sses	sor:	Kath	nryn	Reev	ve			Date	: 22	/02/2	2017	,					
									(Cate	gory											
Habitat parameter		(Optim	al			Sub	oopti	mal			Ma	argin	al				Poo	r			
1. Riparian vegetative zone width	•	veg >10	tinuou		er	•	is <1	tation 0m	n buff ntinue		•	Path and/o Most over	or sto	ck	ent	•		nan a	equei ctivity			
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: 11	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
Mean: 13.5		1													1					<u> </u>		
2. Vegetative protection	•	imm zon nati Tree stor non pres Veg	k surfa ediate es cov ve veg es, und ey shr -wood sent etative uption	e ripar rered letatio der- ubs o y plar	ian by on r nts	•	nativ Disru Bank	ered n re veg uption ks ma red b	nainly getati n evid	on lent	•	Bank cove mixtu grass black & intr spec Vege disru Bare cropp vege comr	red b ure of ses/sl berry roducties etation ption soil/co tatior	y hrubs , will ed n obvie close	ow	•	cove gras Disr strea vege high Gras graz Sigr	ered b ses & uption am ba etatio ss he red uificar	shru n of ank n ver	ubs y ck		
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: 8	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
Mean: 13.5																						
3. Bank stability	•	Eros failu abs <5%	ks sta sion/ba re ent/mi 5 of ba cted	ank nimal		•	Infreater areat most over	quen s of e tly he % of	ly sta t, sma erosio aled bank	all n	•	Mode unsta 30-60 reach of ero High poter flood	able 0% of n has osion erosi ntial c	f bani area	S	•	Man area 60-1 has	y ero is 00% erosi	of ba	ınk		
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:18	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
Mean: 18		<u> </u>			<u> </u>															-		
4. Frequency of riffles	•	freq Dist riffle stre	es rela uent ance l s divid am wid ety of ety	betwe ded b dth=5	en y -7	•	Dista riffles	s infre ance s divi	ce of equer betwe ded b dth=7	een y	•	Occa or ru Botto provi habit Dista riffles strea 25	n de so at ince t s divio	ontour ome oetwe ded b	rs een y	•	 Unstable Many eroded areas 60-100% of ban has erosional scars 5 4 3 2 5 4 3 2 6 4 3 2 6 6 - 100% of ban has erosional scars 					
Score: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
5. Channel alteration	•	cha abs Stre	nges nnel/d ent/mi am wi nal pa	redgii nimal th		•	chan Evide chan Rece chan	inel/d ence inel/d ent	anges iredgi iredgi iredgi nt	ng Ist ng	•	Char chan exter Emba oring prese bank 40-80 Char disru	ges/c nsive ankm struc ent or s 0% of nneliz	ients/ ctures n botl	/sh s n	•	with gabi >80 read char disru	on/ce % of : h nneliz upted ream	ement strear	m r		

		Ca	itego	ory		На	bitat	para	mete	r		Ca	itego	ory		Ha	bitat	para	mete	r		
Habitat parameter		0	ptim	al								0	ptim	al								
6. Sediment deposition	•	Little, point <20% affec sedin depo	bars of bo ted by nent	prese ottom /	nt	•	form from or fin 20-50 affec	ation, grave le sed 0% of ted t depo	ase in most l, san iment botto ositior	ly d t m	•	Some new g fine s old & 50-80 affect Sedin at ob const bend	grave edim new 0% of ted nent o struct	l, sand ent or bars botto depos tions,	d or n m	•	Heav fine r lncre devel >80% chang frequ Pools abser sedin depo	ased opmo of bo ging ently almo nt due	bar ent ottom ost e to			
Score: 20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
7. Velocity/depth regimes	•	4 velo regim Slow/ slow/ fast/s fast/o	ies pr deep shallo	esent , ow,		•	regin If fas	tity/de nes pr t/shal ng the	esent	;	•	2 of 4 veloc regim If fast slow/ missi	ity/de nes pr t/shall (shallo	iesent low o ow are	r e	•	veloc regin	ity/de ne	d by 1 epth ep/slo			
Score: 9	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% favou inver colon variet debri mats Snags logs/ banks provi fish c Must trans	rable tebra isatic ty of v s, riff s/ sub under s/cob des a over not b	for te woody les, ro merg cut bles bunda	y oot ed ant	•	favou inver color Snags logs/ banks Fish o Mode of ha Can o	urable tebra hisatic s/ sub under s/cob cover erate bitat	te omerg cut bles comn variet types. t of so	ed non sy	•	10-30 favou inver colon Fish c 60-90 easily foot Wood or ma smot sedin	irable tebra isatic over 0% su v mov dy del ay be herec	for te patch bstrat ed by bris ra	y e	•	abser Subst or lac Stabl	urable tebra iisatic cover nt trate cking e hab ng or	e for te on rare o unsta itats limite	ble		
Score: 17	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
9. Periphyton	•	Perip evide held s (maci wood sedin	nt on subst rophy etc.,	hand rates rtes,) or fi		•	visibl subst	rates		n	•	Perip <20% availa	cove			•	& prolific					
Score: 18	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
TOTAL SCORE: 148																						

Stream name: Waitaw	heta River				Assesso	r: Pete	r Williams			
Site number: 1235-11		Samp	le number: 2		Date: 13	3/02/2	017	Гime	: 15:00	
GPS coordinates		Dowr	nstream:		E 18454	80	I	N 584	49622	
		Upstr	ream:		E 18453	88	ı	N 584	49622	
Channel & riparian	features				Instrea	m hye	draulic co	ndit	ions	
Canopy cover:					Estimate	d or me	asured reac	h ave	rage:	
Open	Partly s	haded	Very sh	aded						
Fencing:	Dominant	riparia	n vegetation:		Stream	width	(active cha	nnel): 5.1m	
None/ineffective	Crops		Retired veg	etation	Stream	width	(water): 3.3	35m		
One side/partial	Pasture		Native shru	b	Stream	depth:	0.13m			
Complete	Exotic tree	s	Native trees	5	Surface	velocit	ty:			
Water quality										
Temperature:	18.3		°C		Conduc	tivity:	6	56.8	μS	cm ⁻¹
Dissolved oxygen:	93.1		%		8.62		r	ng l ⁻¹	1	
Turbidity:	Clear		Slightly turbid	Highly t	urbid	Stair	ned		Other	
Stream-bottom sub	strata									
Compaction (inorgani	c substrata):				% surfic		rganic sub	strat	um size	
Assorted sizes tightly	backed &/or	overlap	oping		Substra	tum	Dimensio	on	Percent	tage
Moderately packed w	ith some ove	erlappi	ng		Bedrock	(-			
Mostly a loose assortr	nent with litt	le over	lap		Boulder		>256mm		15	
No packing/loose asso	ortment easily	y move	d		Cobble		>64-256mm	n	70	
Embeddedness:					Gravel		>2-64mm		10	
(% gravel-boulder particle	es covered by f	ine sedi	ment)		Sand		>0.06-2mm		5	
<5% 5-259	% 26-5	50%	51-75%	>75%	Silt		0.004-0.06r	nm		
					Clay		<0.004mm			
Organic material (%	6 cover)				Habita	t type	s sample	d		
Large wood (>10cm di	ameter)				(% of eff	ort)				
<5% 5-259	% 26-5	50%	51-75%	>75%	Stones:		90%			
Coarse detritus (small	wood, sticks	, leaves	s etc.,. >1mm)		Wood:		%	Ri	ffles:	70%
	6 26-5	50%	51-75%	>75%	Macrop	hyte:	%	Ru	ins:	30%
<5% 5-25 %	leposits				Edges:		10%			
<5% 5-25 9 Fine (<1mm) organic o		- 00/	51-75%	>75%	Numbe	r of inv	ertebrates	retu	rned:	
I	% 26-5	50%			Koura:	(5	Shrin	nps: N	
Fine (<1mm) organic c			ea)					Muss	els: N	
Fine (<1mm) organic o	er (% stream		ea)		Crabs: N	1	r			
Fine (<1mm) organic c <5% 5-259 Instream plant cove	er (% stream	bed are	ea) 51-75%	>75%	Crabs: N Other:	1	ľ			
Fine (<1mm) organic o <5% 5-25% Instream plant cove Filamentous algae & n	er (% stream	bed are	, 1 1	>75%			ſ			
Fine (<1mm) organic c <5% 5-259 Instream plant cove Filamentous algae & n <5% 5-259	er (% stream nats: % 26-5	bed are	, 1 1	>75% >75%	Other:		ſ			
Fine (<1mm) organic c <5% 5-259 Instream plant cove Filamentous algae & n <5% 5-259 Macrophytes:	er (% stream nats: % 26-5 % 26-5	bed are	51-75%		Other:		1			

Stream name: Waitaw	vheta	Rive	r					5	Site n	umb	er: 12	235-1	.1										
Sample number: 2				A	ssess	or: P	eter	Willia	ams				Date	: 13/	02/20	017							
Habitat parameter		(Optim	al			Sub	popti	mal	Cate	gory		argin	al				Poor					
1. Riparian vegetative zone width	•	vege >10r	tinuou		er	•	<10n	tation			•	Pathy and/o Most	or sto	ck		•	Hum	nan ac					
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: 13	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			
Mean: 14.5																							
2. Vegetative protection	•	imm zone nativ Tree shru woo pres Vege	c surfa ediate es cove ve veg s, und bs or i dy pla ent etative uption	e ripar ered b etatio er-sto non- nts	ian Y n orey	•	cover nativ Disru Bank	surfa red m e vege ption s may red by try	ainly etatio evide be	n ent	•	Bank cover of gra black & intr speci Vege disru Bare cropp comr	red by asses/ berry, roduc es tation ption soil/cl ped ve	mixt shrub willo ed obvio losely	us	•	cove & sh Disre strea vege high Gras graz Sign	ered by rubs uption am ba etation es heav ed	y gras of nk very vily	¢			
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: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			
3. Bank stability	•	Eros failu abse	ent/mi of bai	ank nimal		•	Infre areas most	eratel quent s of er ly hea % of b ed	, sma osion lled o	II	•	Mode unsta 30-60 reach erosid High poter flood	ible)% of i has a on erosic ntial d	bank areas	of	Significant stock damage to bank 5 4 3 2							
Left bank: 17	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	:			
Right bank: 18	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			
Mean: 17.5								1	L			<u> </u>					<u>.</u>			-			
4. Frequency of riffles	•	freq Dista riffle strea	es rela uent ance b es divid am wid ety of	etwee led by dth=5	en / -7	•	Dista riffle:	s infre	quen etwee led by	en /	•	Occas run Botto provi habit Dista riffles strea 25	om con de son at nce bo s divid	ntour me etwee led by	s en	• • •	wate riffle Poor Dista riffle	4 3 2 ank surfaces overed by grasse overed by grasse shrubs isruption of tream bank egetation very igh rass heavily rass heavily razed bank 4 3 2 4 3 2 4 3 2 4 3 2 4 3 2					
Score: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			
5. Channel alteration	•	char abse Strea	nges to nnel/d ent/mi am wi nal pa	redgir nimal th	-	•	chan Evide chan Rece chan	nel/dr	edgir f past edgir	ng : ng	•	Chan chang exter Emba ing st prese banks 40-80	ges/di isive inkme ructu ent on	ents/s res both reach	hor	•	gabi >809 reac or d Instr	on/ce % of st h char isrupte eam h	ment ream nneliz ed nabita	ed			

		Ca	atego	ory		Ha	bitat	para	mete	r		Ca	itego	ry		Ha	bitat	para	mete	er
Habitat parameter		0	ptim	al								0	ptim	al						
6. Sediment deposition	•	point	bars of bo ted b nent		nt	•	form from or fin 20-50 affec	depo	most I, san iment botto	ly d t m	•	fine s old & 50-80 affect Sedin at ob	gravel edim new 0% of ted nent o struct	l, sand ent or bars botto depos cions,	dor n m	• •	fine Incre deve >80% chan frequ Pool abse sedir	mater ased lopm 6 of b	bar ent ottom v ost e to	
Score: 20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Velocity/depth regimes	•		nes pi /deep /shallo shallo	ow,		•	regin If fas	ity/de nes pr t/shal ng the	esent low is	;	•	2 of 4 veloc regim If fast slow/ missi	ity/de nes pr t/shal	esent low o ow are	r e	•	velo regir	city/d ne	d by 1 epth ep/slo	
Score: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	•	favou inver color varie debri mats Snag logs/ bank provi fish c	urable tebra isatic ty of s, riff s/ sub unde s/cob des a over not l	ite on & v wood iles, ro omerg rcut	y oot ed ant	•	favou inver color Snags logs/ bank Fish o Mode of ha Can o	0% sul irable tebra iisatio s/ sub under s/cob cover erate bitat t consis mater	for te merg cut bles comn variet types t of so	ed non sy	•	favou inver colon Fish c 60-90	tebra iisatio cover 0% sul 7 mov dy del ay be hered	for te n patch bstrat ed by bris ra	y e	•	favo inver color Fish abse Subs or la Stab lacki	urable rtebra nisatio cover nt trate cking le hat	ite on rare o unsta bitats limite	ble
Score: 13	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	•	held Stabl	ent or stone e sub ces re	n hand	!	•	visibl Stabl	hytor e on s e sub: hytor uch	tone: strate		•		hytor cove able s	r of		•	Periț & pr >209 avail			
Score: 8	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 141.5																			•	

Appendix B Fish surveys

Fish o	collectior	n form	n – Wa	adeable	stream	s/rivers												
Team m Kathryn	iembers: Reeve, Pete	r William	ıs,		GPS (d/s):	E1818698	N5	5838814	Site:	Mai	ngakahika S	Stream				Date:	14/02/20	17
Mike Ma	artin, Elizabet	h Graha	ım		GPS (u/s):	E1818618	N5	5838767	No	ot fished	Fished colled			ed 10 sub- eaches	Fished 5-9 sub-reaches		<5 sub- ches	FLAG for fished/not fished
Fish sample i	id: P.W.	Total time (54	Fishing time:	Start Finish	12:48 15:15	Sample distance	(m):	50	Wetted (m):	width	A B	2.6 C 2.1 D		0.5 2.4	G 1.7 H 2.1	l 2.5 J 2.0
Samplin		Spotlig	iht	EFM	s		ength (m) Iesh (mm)		Wate visib		Good	Averag	е	Poor	Water temp. (°C):	18.5	Conducti (µS):	ivity 176.8
EFM an		Big Small	EFM	volts (x100)): 3			lse rate (Hz	or pps):	60	EFM pu	lse width	(ms)			light (watt		<u> </u>
Species	i		А	В	С	D	Sub-re E	ach tally F	G	н			J	Total count	Sample count	Length Min.	(mm) Max.	FLAG
C. bully			9	5	7	4	2	7	24	8	9	2	2	77		25	69	
Banded	kokopu		1		2	4	1		4	6				18		52	226	
Shortfin	eel		1	4	1	2	1	1	3	7	2	Ę	5	27		107	370	
Longfin	eel					1	1				2			4		302	603	
Inanga									1		1			2		125	125	
Koura			1	1										3				
Unidenti	ified eel		1	1		1	1	1		1	2			9				
Total			13	11	10	12	6	9	32	22	16	ę)	140				
FLAG	Comment								FLA		mment							
	Water level	very lov	v compa	ared to prev	ious years						ssed bully to							
										Mis	ssed eel tota	al: 9 (incl	uded	in count as	"unidentified e	els")		

Team m Kathryn	embers: Reeve, Mike	Martin,	Kit Squi	res,	GPS (d/s)	- F	1831914	N	5803819	Site	Wait	oa Stream	1249-1	121				Date:	20/0	2/2017	7
Elizabetl	n Graham, G	areth va	n Assen	na	GPS (u/s)		1831878	N	5803808	No	ot fished	Fished colled			ed 10 sub- eaches		ed 5-9 eaches		d <5 sub aches	-	FLAG for fished/not fished
Fish sample i	d: K.R.	Total time (50	Fishi time:		Start Finish	9:09 11:03	Sample distance	(m): 1	50	Wetted (m):	width	AB	1.5 C 2.1 D	-		1.7		2.2 1.1	l 1.4 J 2.1
Samplin		Spotlig	ht	EFM		Seir		ength (m) esh (mm)		Wate visib		Good	Avera	ge	Poor	Water temp.		19	Conc (µS)	ductivi :	^{ty} 109.2
EFM and		Big Small	EFM	volts (x100)): 3			EFM pul	se rate (Hz	or pps):	60	EFM pu	lse widt	h (ms)	: 2		Spotli	ight (watt	s):		
Species			A	В	1	С	D	Sub-re	ach tally F	G	Н		Ì	J	Total count	Sam cou	•	Length Min.	(mm)	κ.	FLAG
C. bully			3			1	3	_			1			-	8			32		'8	
Shortfin			3	7		4	5	3	6	2	9	2		4	45			95		75	
Longfin e	eel										2				2			409	76	68	
Koura			1			1	3			1				5	11						
Unidenti	fied eel		1	1		4	3			2				2	13						
Total			8	8		10	14	3	6	5	12	2		11	79						
FLAG	Comment							1		FLA	G Com	ment									
	Had heavy	rain ove	r 4 davs	prior to sar	mplina								tal: 1 (i	nclude	d in count)						
			y	•	. 0										d in count a	s "unide	entified	eels")			

Fish o	collection	form	– Wa	adeable	streams	/rivers													
Team m Kathryn	nembers: Reeve, Mike I	Martin, ł	Kit Squi	ires,	GPS (d/s): E	E 1836783	N 5	809932	Site	: Mar	ngapapa St	ream 43	33-14				Date:	20/02/20	17
Elizabet	h Graham, Ga	areth var	n Asser	ma	GPS (u/s): E	E 1836750	N 5	809802	N	ot fished	Fished colled		-	ed 10 sub- eaches		ed 5-9 eaches		<5 sub- ches	FLAG for fished/not fished
Fish sample i	M.M./ id: E.G.	Total s time (r		60	Fishing time:	Start Finish	12:00 14:30	Sample distance	(m): 1	50	Wetted (m):	width	A B	5.3 C 4.7 D	5.1 3.9			G 3.7 H 5.8	l 3.1 J
Samplin	ng gear:	Spotlig	ht	EFM	Sei	Le	ength (m) esh (mm)	1	Wat	er bility:	Good	Avera	ge	Deer	Water temp.		20.7	Conducti (µS):	vity 100.0
EFM an		Big mall	EFM	volts (x100)	: 3			se rate (Hz	or pps):	60	EFM pu	lse widt	h (ms)	: 2		Spotli	ght (watts	s):	
Species	;		А	В	C	D	Sub-rea	ach tally F	G	Н		1	J	Total count	Sarr cour		Length (Min.	(mm) Max.	FLAG
C. bully			6	2	14	5	7	9	9	5	4			61			22	61	
Banded	kokopu		1											1			50	50	
Shortfin			14	2	30	12	24	93	24	15	7			221			78	495	
Longfin	eel			2	2	3			1		1			9			179	1605	
Koura			1		1		1		1		2			6					
Unidenti	ified eel		1	1	5	2	3		2	2	3			19					
Total			23	7	52	22	35	102	37	22	17		0	317					
FLAG	Comment								 FLA		mment								
TLAG		wor 1 de		r to complia	2				FLA		sed bully to	tal: 5 (ii	ocludo	d in count)					
	Heavy rain c Reach J too			n to samplir	iy						,			d in count)	"unide	entified	eels")		
			-									``					,		

Fish o	collection	form	n – Wa	adeable	streams	/rivers											
	nembers: Reeve, Paul F	ranklin	n, Mike I	Martin,	GPS (d/s):	E 1817745	N S	5815748	Site:	Wait	takaruru Stre	am 1231	54		Date:	14/02/20)17
Peter W	/illiams, Elizabe	eth Gra	aham		GPS (u/s):	E 1817903	NS	5815670	No	ot fished	Fished n collecte		shed 10 sub- reaches	Fished 5-9 sub-reaches		<5 sub- ches	FLAG for fished/not fished
Fish sample	K.R./ id: P.F.	Total time (57	Fishing time:	Start Finish	8:46 11:15	Sample distance	(m):	50	Wetted w (m):	idth <u>A</u> B	1.8 C 1.9 D			G 2.8 H 0.8	J 2.3
Samplin		Spotlig	ht	EFM	Se		ength (m) lesh (mm)		Wate Visib		Good	Average	Poor	Water temp. (°C):	19.4	Conduct (µS):	^{ivity} 134.0
EFM an		Big mall	EFM	volts (x100)	: 3			se rate (Hz	or pps):	60	EFM puls	e width (m			ight (watts		
Species			А	В	С	D	E	ach tally F	G	н	1	J	Total count	Sample count	Length (Min.	Max.	FLAG
C. bully			6	6	1	5	1	1	9	3	1	2	35		15	73	
Shortfin	eel		6	2	6	5	2	3	14	2	6	1	47		94	525	
Longfin	eel		1	1				1					3		132	480	
Koura				3	5	3	4	2	4	6	13	6	46				
Unident	ified eel		1			2		1	2	3			9				
Total			14	12	12	15	7	8	29	14	20	9	140				
FLAG	Comment						1	I	FLA		nment				l	1	
	Lots of macro	ophyte	s across	s entire read	h; made ele	ectric-fishing	g difficult				,		ded in count) ed in count as	"unidentified e	els")		
												•			,		

Fish c	ollection	n form	– Wa	deable	streams	/rivers									i		
Team me Kathryn F	embers: Reeve, Eliza	beth Gra	aham,		GPS (d/s): E	1831220	N 5	809988	Site	Piak	onui Strear	n 753-15	i		Date:	21/02/2	2017
Mike Mar	rtin, Mike Me	eredyth-	Young		GPS (u/s):				No	ot fished	Fished collec		Fished 10 sub- reaches	Fished 5-9 sub-reaches		l <5 sub- aches	FLAG for fished/not fished
Fish sample io	d: M.M.	Total time (61	Fishing time:	Start Finish	10:05 12:20	Sample distance	(m): 1	50	Wetted (m):		-	C 2.9 E D 5.5 F		G 3. H 3.	
Sampling	g gear:	Spotlig	lht	EFM	Sei		ength (m) esh (mm)		Wate Visib		Good	Average	Poor	Water temp. (°C):	16.6	Condu (µS):	ctivity 72.2
EFM ano		Big Small	EFM	volts (x100)	: 3		EFM puls	se rate (Hz	or pps):	60	EFM pul	se width	(ms): 2	Spo	tlight (watt		
Species			А	В	C	D	Sub-rea	ach tally F	G	н		J	Total count	Sample count	Length Min.	(mm) Max.	FLAG
Shortfin e	eel		2			2	2	3	20	2	4	4	39		95	151	
Longfin e	eel				1						1		2		455	935	
Koura			3	9		5	22	26	26	28	53	30) 202				
Unidentif	fied eel						1	1					2				
Total			5	9	1	7	25	30	46	30	58	34	245				
FLAG	Comment								FLA	G Corr	nment						<u> </u>
	Heavy rain	2-5 days	s prior to	sampling								l: 2 (inclu	ided in count a	as "unidentified	eels")		

Fish collection	n forn	n – Wa	deable	streams	/rivers											
Team members: Kathryn Reeve, Pete	r Williar	ns,		GPS (d/s):	E 184102	27	N 5867879	Site:	Paial	karahi Strean	n D/S 718	-5		Date:	13/02/20	17
Mike Martin, Elizabet	h Graha	am		GPS (u/s):	E 184109	98	N 5867799	No	ot fished	Fished no collected		hed 10 sub- reaches	Fished 5-9 sub-reaches		<5 sub- ches	FLAG for fished/not fished
Fish sample id: P.W.		shock (min):	69	Fishing time:	Start Finish	10:10 13:03	Sample distance	(m): 1	50	Wetted wie (m):	dth <u>A</u> B	5.7 C 2.5 D			G 4.3 H 2.4	l 3.4 J 4.2
Sampling gear:	Spotli	ght	EFM	Sei		ength (m) esh (mm)		Wate Visib	-	Good A	verage	Poor	Water temp. (°C):	18.5	Conducti (µS):	^{vity} 124.4
EFM anode:	Big Small	EFM	volts (x100)	: 4			lse rate (Hz o	or pps):	60	EFM pulse	width (ms	-		light (watts	· · · · · · · · · · · · · · · · · · ·	
Species		А	В	С	D	Sub-re E	each tally F	G	Н	1	J	Total count	Sample count	Length Min.	Max.	FLAG
C. bully		6	2	5		1	5	8	4	5	2	38		20	71	
Redfin bully					1							1				
Shortfin eel				3	1	4			1	1		10		89	165	
Longfin eel		1		1		1			1	1	2	7		109	1016	
Torrentfish										1		1		122	122	
Rainbow trout		1				1		1			2	5		92	133	
Koura		1	7	8	17	4	9	6	13	2	3	70				
Unidentified eel						3				1	1	5				
Total			-													
Total																
FLAG Comment								FLA		ment						
Deep pool	present	in reach	1, difficult to	o fish									; 1 was redfin			
									Miss	ed eel total:	5 (include	d in count as	s "unidentified o	eels")		

Image: concerner of the construction of the	1848393 N 5823235 Site: Karengorengo Stream 232-3 Date: 21/02/20	17
sample id: Yes time (min): 31 time: Finish 17:14 distance (m): 150 (m): B 1.8 F H 2.4 Sampling gear: Spotlight EFM Seine Length (m) Water visibility: Good Average Poor Water temp. (C) 1.8 F H 2.4 Spotlight Big Small EFM volts (x100): 3 EFM pulse rate (Hz or pps): 60 EFM pulse width (ms): 2 Spotlight (watts): Species A B C D E F G H I J Count Spotlight (watts): Species A B C D E F G H I J Count Spotlight (watts): Species A B C D E F G H I J Count Spotlight (watts): Species A B C D B A I I B I I I I I I		FLAG for fished/not fished
Spating gealSpating itLimitSerieMesh (mm)visibility:OddAverageFourtemp. (*C):1:3.0(µS):EFM ande:Big SmallEFM volts (x100):3EFM pulse rate (Hz or pps):60EFM pulse width (ms):2Spatight (watts):SpeciesABCDEFGHIJcountCountMin.Max.C. bully31111EFGHIJcountMin.Max.Shortfin eel251411102537082530Smelt1311313775986Gambusia13112112327Rainbow trout111112112327Rainbow trout13112112320Koura233112112323Vididetified eel35311215112152320Total23251212152320152320Koura23311212152152152152152152152152152152152152152152154154154	Finish 17:14 distance (m): 150 (m): B 1.8 D 1.8 F H 2.4	l J 2.9
EFM ande: Small EFM volts (x100): 3 EFM pulse rate (Hz or pps): 60 EFM pulse width (ms): 2 Spotight (watts): Species A B C D E F G H I J count Sample count Length (mn) C. bully 3 1 1 1 0 2 5 3 70 882 530 Shortfin eel 25 14 11 10 2 5 3 70 882 530 Small I 3 1 1 1 2 88 6 Gambusia 1 3 I I 3 2 5 3 70 882 530 Koura 2 3 3 1 1 2 152 320 320 Koura 2 3 3 1 1 1 2 162 320 Gambusia 3 5 3 1 1 1 2 162 320 320 <	he Length (m) Water visibility: Good Average Poor Water temp. (°C): 19.0 Conduct (μS):	^{vity} 191.4
A B C D E F G H I J count count Min. Max. C. bully 3 1 1 1 1 5 11 32 89 Shortfin el 25 14 11 10 2 5 3 70 82 530 Smelt 3 1 3 1 3 7 59 86 Gambusia 1 3 1 1 3 77 59 86 Gambusia 1 3 1 1 3 7 59 86 Gambusia 1 3 2 5 1 2 152 320 Koura 2 3 5 3 1 1 2 16 152 320 Unidentified eel 3 5 3 1 1 2 16 1 1 Total 1 1 1 2 16 1 1 1 1 1		
Shortfin eel 25 14 11 10 2 5 3 70 82 530 Smelt 3 1 3 1 3 7 59 86 Gambusia 1 3 1 3 1 3 7 59 86 Gambusia 1 3 1 3 1 3 7 59 86 Gambusia 1 3 1 3 1 3 4 23 27 Rainbow trout 1 1 1 1 2 152 320 Unidentified eel 3 5 3 1 1 2 16 152 320 Unidentified eel 3 5 3 1 1 2 16 152 320 Unidentified eel 3 5 3 1 1 2 16 16 16 17 Total 1 1 1 1 1 1 1 1 16 16 16		FLAG
Smelt Image: Smelt in the second	1 5 11 32 89	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	10 2 5 3 70 82 530	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	3 1 3 7 59 86	
Koura2332 5 112 1 1 Unidentified eel35311 1 2 16 1 1 I		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	1 2 152 320	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	3 2 5 12	
FLAG Comment FLAG Comment FLAG Comment Skipped reaches F, G, and I because too weedy to fish FLAG Comment Missed bully total: 1 (included in count) Missed 6 m in reach C because it was too weedy to fish Missed smelt total: 2 (included in count)	<u>1 1 1 1 2 16</u>	
Skipped reaches F, G, and I because too weedy to fish Missed bully total: 1 (included in count) Missed 6 m in reach C because it was too weedy to fish Missed smelt total: 2 (included in count)		
Skipped reaches F, G, and I because too weedy to fish Missed bully total: 1 (included in count) Missed 6 m in reach C because it was too weedy to fish Missed smelt total: 2 (included in count)	Image: state Image: state<	
Skipped reaches F, G, and I because too weedy to fish Missed bully total: 1 (included in count) Missed 6 m in reach C because it was too weedy to fish Missed smelt total: 2 (included in count)		
Skipped reaches F, G, and I because too weedy to fish Missed bully total: 1 (included in count) Missed 6 m in reach C because it was too weedy to fish Missed smelt total: 2 (included in count)	FLAG Comment	<u> </u>
Missed 6 m in reach C because it was too weedy to fish Missed smelt total: 2 (included in count)		
Missed 5 m in reach e decause it was too weedy to fish		
Saw school of smelt just above the end of reach J		

Team m Kathryn	embers: Reeve, Pe	ter Williar	ns,		GPS (d/s):	E 1851649	N 5	5819801	Site	Wair	ere Strean	า 1224-5	5				Date:	15/02/20	17	
Mike Ma	artin, Elizab	eth Grah	am		GPS (u/s): E	E 1851719	N 5	5819721	No	ot fished	Fished collec			ed 10 sub- eaches		ed 5-9 eaches		<5 sub- ches	FLAG fished/r fished	not
Fish sample i	id: K.R.		shock (min):	152	Fishing time:	Start Finish	9:45 15:15	Sample distance	(m): 1	50	Wetted (m):	width	A B	5.6 C 6.7 D				G 5.6 H 3.8	l J	5.7 4.5
Samplin		Spotli	· /	EFM	Sei	ne <u>L</u> e	ength (m) esh (mm)		Wate Visib		Good	Averag	e	Poor	Water temp.		16.6	Conducti (µS):	vity 5	54.5
EFM an	ode:	Big Small	EFM	volts (x100): 3		EFM puls	se rate (Hz	or pps):	60	EFM pul	se width	n (ms)	: 2		Spot	light (watts	s):		
Species			A	В	С	D	Sub-rea	ach tally F	G	Н			J	Total count	San cou		Length (Min.	(mm) Max.	FLAG	3
C. bully Shortfin Longfin			53 43	21 17	6 17	47 10	40 17	34 16	74 26	42 35	62 19	7		453 225 2			16 80 632	665		
Koura Unidenti			3	5	6	3	4 2		5 2	4	2		1 1 2	29 32			032	700		
Total			103	49	35	62	63	50	107	81	88	1()7	741						
												_								
FLAG	Comment								FLA		iment		<i>.</i>							
				s not captu	es simultane red by EF	ously								ided in cour d in count a		entified	eels")			

Fish o	collection form	n – Wae	deable	streams	/rivers											
Team m Kathryn	embers: Reeve, Mike Martin			GPS (d/s):	E 1852566	N	5818150	Site:	Waite	eariki Strear	n 1430-10			Date:	22/02/20	17
Elizabet	h Graham, Callum E	rown		GPS (u/s):	E 1852697	N	5818212	No	ot fished	Fished no collecte		shed 10 sub- reaches	Fished 5-9 sub-reaches		<5 sub- ches	FLAG for fished/not fished
Fish sample		shock (min):	42	Fishing time:	Start Finish	10:25 13:47	Sample distance	(m):	50	Wetted w (m):	idth <u>A</u> B	8.4 C 7.1 D			G 9.5 H 11.3	l 8.6 J 7.3
Samplin		ght	EFM	Se		ength (m) esh (mm)		Wate visib		Good A	Average	Poor	Water temp. (°C):	14.2	Conducti (µS):	vity 38.3
EFM an	ode: Big Small	EFM v	olts (x100)	: 4		-	lse rate (Hz c	or pps):	60	EFM pulse	e width (m			ight (watts	-	
Species	i	А	В	С	D	Sub-re E	ach tally F	G	Н		J	Total count	Sample count	Length Min.	(mm) Max.	FLAG
C. bully		1	1	2	2		1	7	2	1	1	18		36	171	
Shortfin	eel	1		1	1			5	3		1	12		110	195	
Longfin				1	1			1	1			4		357	600	
Torrentf	ish				2				1			3		60	136	
Brown tr	rout							1		1		2		123	134	
Koura		2	2	1	2						1	8				
Total		4	3	5	8	0	1	14	7	2	3	47				
FLAG	Comment							FLA	G Com	iment						
	Heavy rain over 3-				<i>c</i> ,											
	Very strong curren															
	Missed 5 m of read															
	Reach E skipped b															
	Missed 5 m of read	ch F becau	ise too dee	ep and swift	to fish											

Sample Id: Sampling gear: EFM anode: Species C. bully Shortfin eel Longfin eel Rainbow trout Brown trout	K.R. To tim	tal shock e (min): tlight EFM	54 EFM volts (x100)	Fishing time:		N 5 14:56 17:29 ength (m) esh (mm)	849622 Sample distance	(m):	Not fished 150	Fished collec Wetted (m):	ted	shed 10 sub- reaches <u>3.6 C</u> 3.3 D	sub-r		read 3.5	<5 sub- ches G 3.8 H 4.8	FLAG for fished/not fished I 3.5
sample id: K Sampling gear: EFM anode: Species C. bully Shortfin eel Longfin eel Rainbow trout Brown trout	K.R. tim ar: Spo Big	e (min): tlight EFM	EFM volts (x100)	time: Seii	Finish	17:29 ength (m)		(m): Wat									
Sampling gear: EFM anode: Species C. bully Shortfin eel Longfin eel Rainbow trout Brown trout	ar: Spo Big	tlight EFM	volts (x100)	Seir	Le	ength (m)	uistance	Wa	otor	(111).							J 3.6
Species C. bully Shortfin eel Longfin eel Rainbow trout Brown trout		А		: 4				VISI	ibility:	Good	Average	Poor	Water temp.		3.3 18.3	Conductiv (µS):	
C. bully Shortfin eel Longfin eel Rainbow trout Brown trout						EFM puls	se rate (Hz		60	EFM pul	se width (m	s): 2			ght (watts		
Shortfin eel Longfin eel Rainbow trout Brown trout		<u>^</u>	В	С	D	Sub-rea	ach tally F	G	Н		J	Total count	San cou		Length (Min.	(mm) Max.	FLAG
Longfin eel Rainbow trout Brown trout		9	10	12	11	11	5	8	4	8	3	81			36	85	
Rainbow trout Brown trout				3	2	3	1		2			11			117	376	
Brown trout			1			1		1	2		2	7			271	740	
	t							2	1			3			87	104	
										1		1			117	117	
Koura		7	8	2		1	2	1	2	1		24					
Unidentified tro									2			2					
Unidentified ee	el			2	1	1		1	2	2	3	12					
								10									<u> </u>
Total		16	19	19	14	17	8	13	15	12	8	141					
FLAG Comr	nment				I			FLA	AG Cor	nment							1
Wate	ter level lowe	r than previ	ous year						Mis	sed bully to	al: 24 (incl	uded in count	t)				
			•						Mis	sed trout tot	al: 2 (inclu	ded in count a	as "unid	entified	trout")		
									Mis	sed eel tota	l: 12 (inclue	led in count a	as "unide	entified (eels")		

Appendix C Macrophytes and periphyton

Periphyton Assessme	nt						
Stream: Mangakahika Strea	m	Date: 14/	02/2017				
Sample Number: 4		Located r	number: 3	76-4			
Thickness category	Colour category	А	В	с	D	E	Mean cover
Thin (<0.5mm) Mat/Film	NA (% cover)	25					5
Medium mat/film (0.5- 3mm thick)	Green (% cover)						0
Shini theky	Light brown (% cover)	50					10
	Black/dark brown (% cover)			10	5		3
Thick (>3mm) mat/film	Green/light brown (% cover)					5	1
	Black/dark brown (% cover)						0
Filaments short (<2cm)	NA (% cover)			2	2		0.8
Filaments long (>2cm)	Green (% cover)		30				6
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte	recording she	et								
Stream: Manga	kahika Stream		Located nu	mber : 376-4		Sample Number: 4			Date: 14/02/2	2017
						Vegetation co	ver (% w	etted area)		
	Wetted width	Channel width			Sub	merged plants				Emergent plants
Transect	(m)	(m)	Total		Su	face-reaching	Bel	ow surface		
			cover	Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species
1	1.83	2.63	0							
2	1.06	1.56	0							
3	1.55	1.86	0							
4	2.10	2.10	5	5	5	Du (duckweed)				
5	1.95	3.20	0							

Periphyton Assessmer	ht						
Stream: Waitoa Stream U/S		Date: 20/	02/2017				
Sample Number: 6		Located n	umber: 1	249-121			
Thickness category	Colour category	A	В	с	D	E	Mean cover
Thin (<0.5mm) Mat/Film	NA		60	25		10	19
Medium mat/film (0.5- 3mm thick)	Green (% cover)						0
Shin they	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 she	et								
Stream: Waitoa	a Stream U/S		Located nu	mber : 1249-121		Sample Number: 6	5		Date: 20/02/2	2017
						Vegetation co	over (% w	etted area)		
	Wetted width	Channel width			Sub	merged plants				Emergent plants
Transect	(m)	(m)	Total		Su	rface-reaching	Bel	ow surface		
			cover	Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species
1	1.49	6.03	0							
2	2.45	9.60	2						2	Gr 1, Na 1
3	1.70	3.93	23						23	Gr 1, Na 2, Ph 20
4	2.24	3.56	31						31	Gr 30, Ph 1
5	1.40	11.12	0							

Periphyton Assessmer	ıt									
Stream: Mangapapa Stream		Date: 20/02/2017								
Sample Number: 7		Located n	umber: 4	33-14						
Thickness category	Colour category	A	В	с	D	E Mea				
Thin (<0.5mm) Mat/Film	NA	80	20				20			
Medium mat/film (0.5- 3mm thick)	Green (% cover)			20			4			
	Light brown (% cover)		20	30			10			
	Black/dark brown (% cover)						0			
Thick (>3mm) mat/film	Green/light brown (% cover)						0			
	Black/dark brown (% cover)						0			
Filaments short (<2cm)	NA (% cover)				80		16			
Filaments long (>2cm)	Green (% cover)						0			
	Brown/Reddish (% cover)						0			
Submerged bryophytes	NA	10	60	50			24			
Iron Bacteria growths	NA						0			

Macrophyte	Macrophyte recording sheet											
Stream: Manga	ipapa Stream		Located number:			Sample Number: 7	,		Date: 20/02/2017			
				Vegetation cover (% wetted area)								
	Wetted width Channel width				Sub	merged plants				Emergent plants		
Transect	(m)	(m)	Total		Su	rface-reaching	Bel	ow surface				
			cover	Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species		
1	5.10		1									
2	3.90		0									
3	2.84		20	5	5	Lm 3, Po 2			15	Gr 10, Ve 5		
4	5.80		40						40	Ph 10, Ve 30		
5	3.10		16	10	10	Lm 10			6	Ph 1, Ve 5		

Periphyton Assessmer	nt									
Stream: Waitakaruru Strean	n	Date: 14/02/2017								
Sample Number: 3		Located r	umber: 1	231-54						
Thickness category	Colour category	A	В	с	D	D E Me				
Thin (<0.5mm) Mat/Film	NA		20		20		8			
Medium mat/film (0.5- 3mm thick)	Green (% cover)						0			
Shin theky	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)	1					0.2			
	Brown/Reddish (% cover)						0			
Submerged bryophytes	NA						0			
Iron Bacteria growths	NA						0			

Macrophyte	e recording she	et										
Stream: Waita	karuru Stream		Located number: 1231-54			Sample Number: 3			Date: 14/02/2017			
				Vegetation cover (% wetted area)								
	Wetted width Channel width				Sub	merged plants	-			Emergent plants		
Transect	(m)	(m)	Total		Su	face-reaching	Bel	ow surface				
			cover	Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species		
1	1.90		50						50	Na 50		
2	2.20		60	30	30	Lm 30			30	Na 30		
3	2.18		70	50	50	Lm 20, Pk 30			20	Na 20		
4	2.80		29	22	22	Lm 10, Pk 10, Du (duckweed) 2			7	Na 2, Ps 5		
5	2.30		70	50	50	Lm 20, Pk 25, Du (duckweed) 5			20	Lp 18, Ps 2		

Periphyton Assessmer	nt									
Stream: Piakonui Stream		Date: 21/02/2017								
Sample Number: 8		Located r	number: 7	53-15						
Thickness category	Colour category	A	в	с	D	D E Me				
Thin (<0.5mm) Mat/Film	NA						0			
Medium mat/film (0.5- 3mm thick)	Green (% cover)						0			
Shin they	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	80	20	35	25	25	37			
Iron Bacteria growths	NA						0			

Macrophyte	Aacrophyte recording sheet											
Stream: Piakon	ui Stream		Located number: 753-15			Sample Number: 8			Date: 21/02/2	2017		
				Vegetation cover (% wetted area)								
	Wetted width	Channel width			Sub	omerged plants				Emergent plants		
Transect	ransect	(m)	Total		Su	rface-reaching	Bel	ow surface				
			cover	Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species		
1	3.77		0									
2	5.54		0									
3	4.66		0									
4	3.34		0									
5	2.58		0									

Periphyton Assessmer	nt									
Stream: Paiakarahi Stream I	D/S	Date: 13/02/2017								
Sample Number: 1		Located r	number: 7	18-5						
Thickness category	Colour category	A	В	с	D	E	Mean cover			
Thin (<0.5mm) Mat/Film	NA	2	20	50	50	5	25.4			
Medium mat/film (0.5- 3mm thick)	Green (% cover)			0.1	0.1	2	0.44			
Shini theky	Light brown (% cover)	5	10	5	10	5	7			
	Black/dark brown (% cover)						0			
Thick (>3mm) mat/film	Green/light brown (% cover)		1	1	3	5	2			
	Black/dark brown (% cover)						0			
Filaments short (<2cm)	NA (% cover)	5	5	2	5	10	5.4			
Filaments long (>2cm)	Green (% cover)	0.1	0.1		0.1	5	1.06			
	Brown/Reddish (% cover)	0.1	0.1	0.1		30	6.06			
Submerged bryophytes	NA		0.1				0.02			
Iron Bacteria growths	NA						0			

Macrophyte	Macrophyte recording sheet											
Stream: Paiaka	rahi Stream D/S		Located number: 718-5			Sample Number: 1			Date: 13/02/2017			
						Vegetation co	over (% w	etted area)	_			
Wetted width Chan		Channel width			omerged plants				Emergent plants			
Transect	(m) (m)		Total		Su	rface-reaching	Bel	ow surface				
			cover Total subme	Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species		
1	2.53		0									
2	4.51		0									
3	3.25		0									
4	2.40		0									
5	4.22		0									

Periphyton Assessmer	nt									
Stream: Karengorengo Strea	am	Date: 21/02/2017								
Sample Number: 9		Located r	number: 2	32-3						
Thickness category	Colour category	A	В	с	D	D E Me				
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)	10					2			
	Brown/Reddish (% cover)						0			
Submerged bryophytes	NA						0			
Iron Bacteria growths	NA						0			

Macrophyte	Macrophyte recording sheet											
Stream: Kareng	orengo		Located number: 232-3			Sample Number: 9			Date: 21/02/2017			
	Wetted width	Wetted width Channel width			Sub	merged plants				Emergent plants		
Transect	(m)	(m)	Total		Surface-reaching Below surface		ow surface					
			cover	r Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species		
1	1.84	2.93	50	10			10	Nh 10	40	Ve 40		
2	1.73	1.75	80						80	Ve 80		
3	1.76	2.23	70						70	Ve 70		
4	2.31	3.12	30						30	Ph 15 Le (gypsywort) 15		
5	2.35	4.38	80						80	Ve 80		

Periphyton Assessmer	nt									
Stream: Wairere		Date: 15/02/2017								
Sample Number: 5		Located r	number: 1	224-5						
Thickness category	Colour category	A	В	с	D	E	Mean cover			
Thin (<0.5mm) Mat/Film	NA						0			
Medium mat/film (0.5- 3mm thick)	Green (% cover)			20			4			
Shin they	Light brown (% cover)						0			
	Black/dark brown (% cover)						0			
Thick (>3mm) mat/film	Green/light brown (% cover)	90	95	40	80	60	73			
	Black/dark brown (% cover)									
Filaments short (<2cm)	NA (% cover)									
Filaments long (>2cm)	Green (% cover)									
	Brown/Reddish (% cover)									
Submerged bryophytes	NA	5					1			
Iron Bacteria growths	NA						0			

Macrophyte	recording she	et									
Stream: Wairer	e		Located number: 1224-5			Sample Number: 5	i		Date: 15/02/2017		
						Vegetation co	over (% w	etted area)			
Wetted width Cha	Channel width			Sub	merged plants				Emergent plants		
Transect	(m) (m)		Total cover		Su	rface-reaching	Bel	ow surface			
				Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species	
1	5.60		0								
2	7.60		0								
3	6.11		2						2	Lp 2	
4	5.47		0								
5	5.70		0								

Periphyton Assessmer	nt									
Stream: Waiteariki Stream	Date: 22/02/2017									
Sample Number: 10		Located r	umber: 1	430-10						
Thickness category	Colour category	A	в	с	D	E	Mean cover			
Thin (<0.5mm) Mat/Film	NA	20	35	10	60	75	40			
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						0			
Iron Bacteria growths	NA						0			

Macrophyte	Macrophyte recording sheet											
Stream: Waitea	ariki Stream		Located nu	mber : 1430-10		Sample Number: 1	0		Date: 22/02/2	2017		
				Vegetation cover (% wetted area)								
	Wetted width	Channel width			Sub	merged plants	-			Emergent plants		
Transect	(m)	(m)	Total		Su	rface-reaching	Below surface					
			cover	Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species		
1	8.40											
2	5.63											
3	7.93											
4	11.33											
5	7.34											

Periphyton Assessmer	t											
Stream: Waitawheta River	Stream: Waitawheta River			Date: 13/02/2017								
Sample Number: 2		Located r	number: 1	235-11								
Thickness category	Colour category	A	В	с	D	E	Mean cover					
Thin (<0.5mm) Mat/Film	NA	25					5					
Medium mat/film (0.5- 3mm thick)	Green (% cover)						0					
Shin theky	Light brown (% cover)	50					10					
	Black/dark brown (% cover)			10	5		3					
Thick (>3mm) mat/film	Green/light brown (% cover)					5	1					
	Black/dark brown (% cover)						0					
Filaments short (<2cm)	NA (% cover)			2	2		0.8					
Filaments long (>2cm)	Green (% cover)		30				6					
	Brown/Reddish (% cover)						0					
Submerged bryophytes	NA						0					
Iron Bacteria growths	NA						0					

Macrophyte	Macrophyte recording sheet											
Stream: Waitaw	wheta River		Located nu	mber : 1235-11		Sample Number: 2			Date: 13/02/2	2017		
						Vegetation co	over (% we	etted area)	_			
	Wetted width	Channel width			Sub	omerged plants				Emergent plants		
Transect	Iransect	(m)	Total		Su	rface-reaching	Below surface					
			cover	Total submerged	Sub- total	Species	Sub- total	Species	Total emergent	Species		
1	3.31		0									
2	3.21		0									
3	3.50		0									
4	3.52		0									
5	4.75		0									

Species	Sites											
	1	2	3	4	5	6	7	8	9	10		
Archichauliodes diversus	44	10	1	1		53		79	7	63		
Antipodochlora braueri						5						
Xanthocnemis zealandica				1								
Acanthophlebia cruentata								9	1			
Ameletopsis percistus						5				21		
Atalophlebioides cromwelli										7		
Austroclima sepia	9	20		292		14	85	44	1	14		
A <i>ustroclima</i> sp.	9			140		9	30	9	3	21		
Coloburiscus humeralis						22		132	14	63		
Deleatidium spp.	237	32		269		27		9	1	14		
chthybotus hudsoni										1		
Neozephlebia scita	44									7		
Vesameletus sp.						27			11	49		
Oniscigaster wakefieldi									1			
Zephlebia borealis	9									1		
Zephlebia dentata	70	32	12	397	17	5	50	62	1	7		
Zephlebia inconspicua				35								
Zephlebia spectabilis	9		24			1				1		
Zephlebia spp.		4	12	82	1	5						
Zephlebia versicolor						5	30			7		
Acroperla sp.									1			
Austroperla cyrene					2							
Zelandoperla decorata					2				1	7		
Aoteapsyche catherinae		13	12									
Aoteapsyche colonica		42	12	70		9		62	3	28		
Aoteapsyche spp.	193	42	12	210	1	35		114	7	42		
Beraeoptera roria						5				14		
Helicopsyche spp.						5				14		
Hudsonema alienum							1	18		14		
Hudsonema amabilis	105		12			9		53				
Hydrobiosella mixta	9											
Hydrobiosis copis		10		1								
Hydrobiosis gollanis (pupae)	1	4										
Hydrobiosis parumbripennis	1	4		1		1		9				

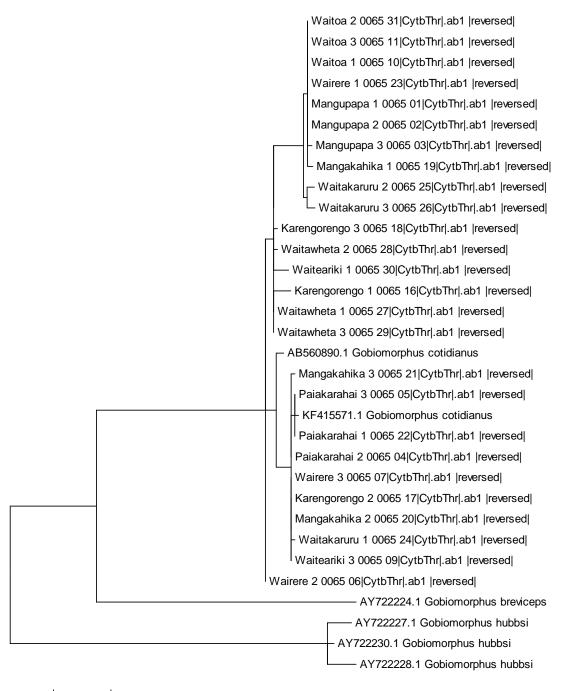
Appendix D Macroinvertebrate taxa list

Waihou and Piako ecological monitoring 2017

	Sites											
Species	1	2	3	4	5	6	7	8	9	10		
Hydrobiosis spatulata										7		
Hydrobiosis spp.	9	10				14		9		14		
Neurochorema armstrongi										7		
Neurochorema spp.	18					9		27				
Olinga feredayi	114									1		
Orthopsyche fimbriata										1		
Orthopsyche sp.					5							
Oxyethira albiceps		7	24	12	1	44	25	35		14		
Polyplectropus sp.	1					9						
Psilochorema sp.	9											
Pycnocentria evecta	70	16	152					210		98		
Pycnocentrodes spp.	447	55	362	164		14			12	21		
Triplectides obsoleta/dolichos	1	4				75	5			1		
Zelolessia cheira									2			
Elmidae (adult)								18				
Elmidae (larvae)	27	10	59	595		136		692	1	7		
Hydraenidae (A)								9				
Hydrophilidae							10					
Ptilodactylidae (larvae)	1			1					1	1		
Aphrophila neozealandica	1					31		79	1	1		
Austrosimulium sp.			12	59	72		45	9		42		
Chironomus zealandicus		7				5						
Corynoneura sp.							10					
Cricotopus sp.					1	27		27	10			
Empididae								18				
Eriopterini sp.						1		1				
Eukiefferiella sp.		7							1			
<i>Hexatomini</i> sp.	1											
Kaniwhaniwhanus sp.									2			
Limonia nigrescens	9											
Lobodiamesinae									1	42		
Macropelopiini sp.	1					31	5	62		14		
Maoridiamesa sp.		10										
Muscidae								1	1			
Naonella forsythi						9		44				

Species	Sites											
Species	1	2	3	4	5	6	7	8	9	10		
Paradixa sp.	27						65					
Pirara					1							
Polypedilum spp.	9	4			1	5	40	9	2	1		
Tabanidae						5						
Tanyderidae	1			1	1							
Tanytarsus spp.		29	1			35	5	53	7			
Latia sp.			59	12		5				14		
Physa sp.							1					
Potamopygrus antipodarum	263	312	2147	665	10	237	600	140	34	756		
Sphaerium sp.			12									
Acarina	9			12								
Eiseniella sp.				12								
Naididae								35				
Oliogochatae unident	9	13	24	47	2	5	10	9		42		
Ostracoda		7					5					
Paracalliope fluviatillis	62			70		18	30	9				
Paranephrops planifrons					1							
Planaria	18		12	12						14		
Sigara spp.			1									

Appendix E Bully phylogenetic analysis



0.020

Figure E-1: Molecular Phylogenetic analysis of bullies. The phylogenetic tree is drawn to scale, with branch lengths measured in the number of substitutions per site.