Waikato Regional Council Technical Report 2018/07

Waihou and Piako ecological monitoring 2016

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

Waikato
REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

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August 2016

Document #: 12368326

Peer reviewed by:
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Approved for release by:
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Prepared for Waikato Regional Council

August 2016

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NIWA CLIENT REPORT No: HAM2016-029
Report date: August 2016
NIWA Project: EVW16219

Quality Assurance Statement		
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	Approved for release by:	Dr D. Roper

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Executive summary

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

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

The results of this survey indicate that, at the Piako survey sites, the relative abundance of fish was generally higher in 2016 than in 2015 and approximately the same or slightly higher than in 2014. The exception to this trend was a decrease in shortfin eels in the Waitakaruru site from 2014 to 2016. Inanga were captured for the first time since 2012 in Mangapapa Stream, although they continued to be absent from the other four sites, including Waitoa, where they were also captured in 2012. A koaro was also captured for the first time in Piakonui Stream. In the Waihou catchment results were more variable. In three of the five sites shortfin and longfin eel abundances were lower in 2016 than in 2015, whereas the abundances of Cran's and common bullies were higher in 2016 than in 2015, although still lower than 2014, in two sites. Fewer trout were captured in 2016 than previous years. Inanga were also absent from one of the two sites in which they were observed in 2015, and banded kokopu were not recorded from two out of three sites in which they had previously been captured. However, redfin bullies were captured for the first time in Waitawheta Stream and mosquitofish, an invasive species, was also recorded for the first time in Karengorengo Stream. Although the introduction of mosquitofish is not optimal, it does suggest, along with the addition or recurrence of inanga, koaro, and redfin bullies, that connectivity within these catchments has improved after several years of low flows and fish are moving more freely throughout the stream network.

Macroinvertebrate communities in the Piako sites improved in total taxonomic richness and EPT richness relative to previous surveys. Percent EPT abundance was more variable, declining in some sites and improving in others. MCI scores were higher in 2016 than 2015 in four of the five sites, although only two were also higher than the 2014 MCI score. In the Waihou catchment, taxonomic richness was lower than 2015 in three sites, although 2016 scores were similar to 2014 scores. EPT richness declined in two sites, increased in two sites, and remained constant in one site between 2015 and 2016. MCI scores, however, were higher than in previous surveys in all sites. In both catchments, macroinvertebrate communities were linked to habitat quality, particularly changes in bank stability and sediment deposition. Macrophyte and periphyton cover also affected macroinvertebrate community composition.

It is recommended that annual ecological monitoring continues at these ten sites. The year-to-year variation observed in the past three years 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. To improve the spatial coverage of the monitoring, it may be valuable to introduce a further group of sites for monitoring once every 3-5 years. This 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 2011; MfE 2014), the Plan includes minimum flow and allocation limits for all catchments in the region (Table 3-5; WRC 2012). Scheduled reviews of the flow and allocation limits are also specified in the Plan (Table 3-4A; WRC 2012).

WRC have 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 et al. 2011; Franklin and Bartels 2012; Franklin et al. 2013; Franklin et al. 2014; Graham et al. 2015a).

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

2 Methodology

2.1 Sites

Monitoring was carried out at ten sites in early March 2016 during the summer low flow period (Table 2-1 & Figure 2-1). The sites were those sampled in 2014 and 2015 following the recommendations of Franklin et al. (2013). The previous samplings were also undertaken in early March; 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 2014-2016 ecological monitoring sites in the Waihou and Piako catchments. Easting and Northing given for downstream limit of survey reach (NZTM coordinates).

Site	Catchment	Stream	Easting	Northing	Distance inland (km)	Elevation (m)
1	Piako	Mangakahika Stream	1818698	5838814	59	62
2	Piako	Waitoa Stream	1831974	5803819	125	157
3	Piako	Mangapapa Stream	1836783	5809932	107	86
4	Piako	Waitakaruru Stream	1817745	5815748	92	63
5	Piako	Piakonui Stream	1831211	5815768	100	160
6	Waihou	Paiakarahi Stream D/S	1841027	5867879	34	60
7	Waihou	Karengorengo Stream	1848393	5823235	100	30
8	Waihou	Wairere Stream	1851649	5819801	108	40
9	Waihou	Waitearikl Stream	1852566	5818150	112	97
10	Waihou	Waitawheta River	1845480	5849662	71	177

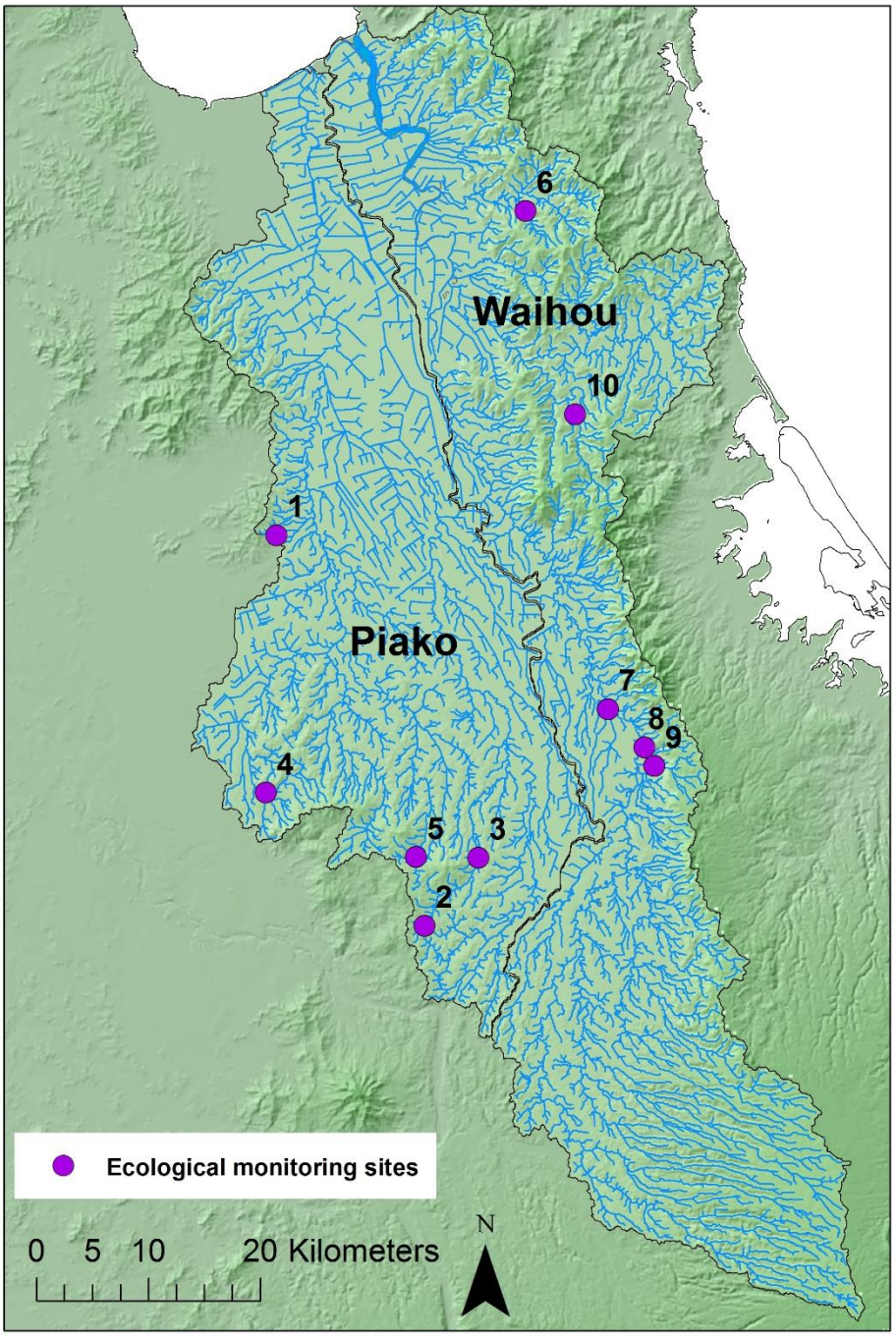

Figure 2-1: Location of the 10 ecological survey sites sampled in the Waihou and Piako catchments during 2014 – 2016. Site numbers refer to those listed in Table 2-1.

2.2 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. In each site, the same voltage was used as in both 2014 and 2015. 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, were 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 are restricted to temporal comparisons at the same site, assuming that the same reach is sampled, with the same level of effort and sampling efficiency on each sampling occasion.

2.3 Macroinvertebrates

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

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

2.4 Macrophytes & periphyton

Macrophyte and periphyton surveys were carried out following the standardised procedures for wadeable streams as outlined by WRC (Collier et al. 2006). At each of five transects located in the reach, periphyton cover was assessed at five points (10%, 30%, 50%, 70% and 90%) across the wetted width of the stream and the area of macrophyte cover occupying the 1 m wide band upstream of the transect was estimated.

Details of the thickness and cover of periphyton were recorded allowing calculation of the Periphyton Enrichment Index (PEI), Periphyton Sliminess Index (PSI) and a range of periphyton biomass indices as defined in Collier et al. (2006). The percentage cover of different submerged and emergent species of macrophytes was also recorded, allowing calculation of the macrophyte cover indices (Collier et al. 2006).

3 Results

3.1 Piako catchment

3.1.1 Fish

Five of the six native fish species found across the five survey sites in the Piako catchment during the 2014 and 2015 surveys were captured in 2016, as were two additional species not recorded in the previous two years (Table 3-1). No exotic species were captured, even though they are known to be locally abundant in some areas of the Piako catchment. Shortfin eels (*Anguilla australis*) were present at all five sites, while longfin eels (*Anguilla dieffenbachii*) were only present at three sites. Longfin eel populations appear to be variable over time; longfin eels were captured in Waitoa stream, where they were absent in 2015, but not captured in Piakonui stream, where they were found in both 2014 and 2015. Koura (*Paranephrops planifrons*), the freshwater crayfish, were found in all five sites, and freshwater shrimp (*Paratya curvirostris*) were recorded for the first time in Waitoa Stream. Bullies were present at all sites in 2016, as they had been in both previous surveys, with common bullies (*Gobiomorphus cotidianus*) present at the sites on the Mangakahika and Piakonui Streams, and Cran's bullies (*Gobiomorphus basalis*) recorded at the sites on the Waitoa, Mangapapa and Waitakaruru Streams. Greater numbers of bullies were captured in all streams in 2016 compared to previous surveys. Banded kokopu (*Galaxias fasciatus*) were captured in the Mangakahika and Piakonui Streams, similar to 2014 and 2015, although abundances were lower in Mangakahika Stream than in past years. Torrentfish (*Cheimarrichthys fosteri*) were not captured in any of the Piako streams, including the Waitakaruru, where they were present in 2014 and 2015. Inanga (*Galaxias maculatus*) were found in Mangapapa stream for the first time since 2012, and a koaro (*Galaxias brevipinnis)* was also captured for the first time in Piakonui Stream. Koaro have never previously been recorded in the Piako catchment based on records in the New Zealand Freshwater Fish Database (NZFFD).

The relative abundance of fish was higher in 2016 than in 2015 in Mangakahika Stream, Waitoa Stream, and Mangapa Stream (Table 3-1, Figure 3-1). In the Mangakahika, shortfin and longfin eel abundances were higher in 2016 than 2015, and similar to the abundances found in 2014. Common bully abundance was also substantially higher in 2016. However, fewer banded kokopu were caught than in either 2014 or 2015.

Waitoa Stream also had greater abundances of shortfin and longfin eels, as well as Cran's bullies, in 2016. Shortfin eel and Cran's bully abundances were the highest observed over all three survey years in this site in 2016.

Mangapapa Stream likewise had the greatest abundances to date of shortfin eels, longfin eels, and Cran's bullies. All three taxa were approximately twice as abundant in 2016 as they had been in 2015. Inanga were also found for the first time in the Piako catchment streams in this site in 2016.

Shortfin eel abundance was lower in Waitakaruru Stream in 2016 than 2015, while the abundance of Cran's bullies was higher than in the previous year. Torrentfish, which had been found in the Waitakaruru in 2014 and 2015, were not captured this year.

In Piakonui Stream, shortfin eel abundances were comparable to previous years, but longfin eels were not found for the first time in the three years of annual surveys. Bully abundance, however, was higher than in previous years, and the relative abundance of banded kokopu was the same as in

2015. Additionally, a koaro was found for the first time in this site; this is also the first time koaro has been captured in any of the monitored Piako or Waihou sites. A sub-sample of bullies were checked for identification in the laboratory and all identified as common bullies. However, given the relative distance inland and size range of some of the bullies captured, and the questions regarding the accuracy of existing keys for distinguishing common and Cran's bullies, some doubt remains regarding the true identification of the bullies at this site. It is likely this will only be resolved with genetic analyses.

Fish species richness was higher in two sites, Mangapapa and Piakonui, in 2016 due to the finding of inanga and koaro, respectively. Fish richness was also higher in Waitoa Stream in 2016 and back to previous levels due to the re-addition of longfin eels which were absent in 2015. Fish species richness in Mangakahika and Waitakaruru Streams remained the same as in 2015.

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 show that the Piako communities are more similar within streams than between streams (i.e., the three sampling dates for each stream cluster closely together; Figure 3-2). The five streams are also all relatively close to the centre of the ordination, indicating they have similar overall composition. Moreover, there is little variation in community composition within each stream over time. The largest change in assemblage structure occurred in Mangakahika Stream between 2014 and 2015; however, by 2016 the community was again similar to the 2014 composition. This pattern reflects the much lower abundances of shortfin and longfin eels in Mangakahika Stream in 2015 than 2014 and 2016. Additionally, Mangapapa is the only site in which the community has continued to shift in the same direction over all three survey years, perhaps indicating a trend. This trend is likely at least partially driven by the large increase in proportion of Cran's bullies within the community in 2016.

Fish length data provide information on fish recruitment and survival rates. A comparison of probability density functions (i.e., the probability of observing a particular value based on the distribution of the data; Quinn and Keough 2002) in each survey year 2014 – 2016 for shortfin eels and the two bully species at the Piako survey sites are shown in Figure 3-3. 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 Cran's and common bullies are given in Table 3-2.

The size distribution of shortfin eels within a site has been fairly consistent between years (Figure 3-3). The size distribution of shortfin eels was right-skewed in most sites, due to the greater numbers of smaller eels than larger eels. This was particularly apparent for the 200-400 mm size class, over which probability density declined in all sites. Moreover, abundances of eels in the smallest size classes (<200 mm) may be slightly under-represented in Figure 3-3 as elvers (juvenile eels) were often too small to be identified as shortfins or longfins in the field and thus recorded as a separate category (Table 3-1). However, unidentified elvers typically were a small proportion of the total eel abundance in each site (Table 3-1).

There were more medium (200-400 mm in length) shortfin eels captured in Mangakahika and Piakonui Streams in 2016 than in previous years, although there continued to be an absence of eels larger than 400 mm in the Piakonui. On the other hand, there were more large (400-800 mm in length) and very large (>800 mm in length) eels captured in Waitoa Stream than in either 2015 or

2014 (Figure 3-3). The scarcity of large eels is consistent with known habitat constraints (i.e., lack of large pools for large eels). 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 in these sites.

The size distribution of bullies was variable between years in most sites. The size distributions were sometimes right-skewed, but often approximately normal (i.e., greatest number of median-sized fish). The distributions were also bimodal in several streams/years, indicating peak densities of multiple size classes. There were more large adults (>50 mm) as well as more juvenile (<30 mm) and young adult (30-40 mm) Cran's bullies in the three sites (Mangapapa, Waitakaruru and Waitoa) where they are present in 2016 than in 2015 (Figure 3-3). In fact, the 2016 distributions more closely resembled the 2014 size distributions than those observed in 2015. However, there were fewer small Cran's bullies in 2016 than in 2014 in both Mangapapa and Waitakaruru Streams. In the Waitoa, on the other hand, the size distribution for 2015 was more right-skewed, indicating more small fish and increased recruitment, than either the 2014 or 2015 size distribution, which was left-skewed towards large adult fish. These variations suggest that recruitment is inconsistent between years. In Piakonui Stream, the size distribution of common bullies in 2016 was very similar to that in 2015 (Figure 3-3), and the population consisted primarily of adult fish (>50 mm). This suggests that this population is primarily sourced by migration/re-distribution within the stream, rather than recruitment. Contrastingly, the common bully population in Mangakahika Stream in 2016 was dominated by juvenile fish, compared to greater proportions of adults in 2014 and 2015 (Figure 3-3).

Longfin eels were only present in low numbers at all sites and the majority of those captured were >400 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; Mangapapa Stream was the only site in which a longfin elver (<100 mm) was captured (Table 3-2). The lack of juvenile longfin eels may relate to either poor recruitment of this species, or an artefact of the limited sampling, as longfin elvers tend to have patchier distributions and may stay closer to the coast for longer compared to shortfins.

Table 3-1: Results of 2014-2016 electric fishing surveys at the five Piako catchment monitoring sites. A = Number caught (abundance); RA = Relative abundance (individuals per 100 m^2). The results from the 2016 survey are in blue; the results from the 2014 and 2015 surveys are included in black for comparison.

Site	Year	Shortfin eel		Longfin eel		Elver		Cran's bully		Common bully		Torrentfish		Inanga		Banded kokopu		Koaro		Koura		Paratya	
		A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA
1. Mangakahika	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	2016	134	54.1	4	1.6	9	3.6	321	129.7	-	-	-	-	-	-	-	-	-	-	50	20.2	1	0.4
	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	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	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	2016	17	3.9	-	-	3	0.7	-	-	34	7.8	-	-	-	-	7	1.6	1	0.2	207	47.7	-	-
	2015	13	4.1	4	1.3	6	1.9	-	-	21	6.7	-	-	-	-	5	1.6	-	-	83	26.5	-	-
	2014	7	1.9	4	1.1	-	-	-	-	22	6.0	-	-	-	-	4	1.1	-	-	200	54.6	-	-

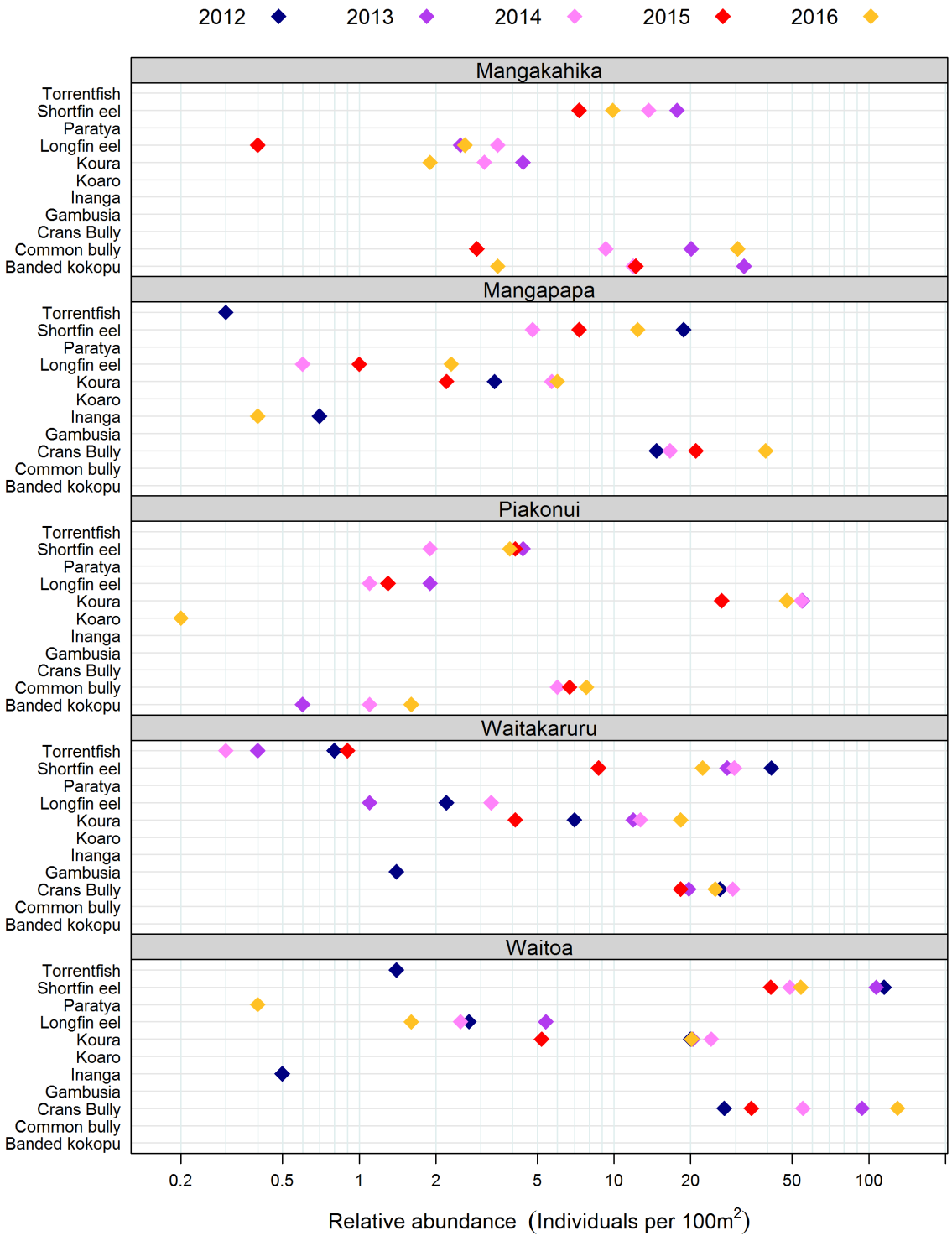

Figure 3-1: Comparison between the relative abundance of fish captured in the 2012 – 2016 Piako surveys. The Mangakahika Stream and Piakonui sites were not surveyed in 2012. The Mangapapa Stream at this location was not surveyed in 2013. Note the logarithmic x-axis.

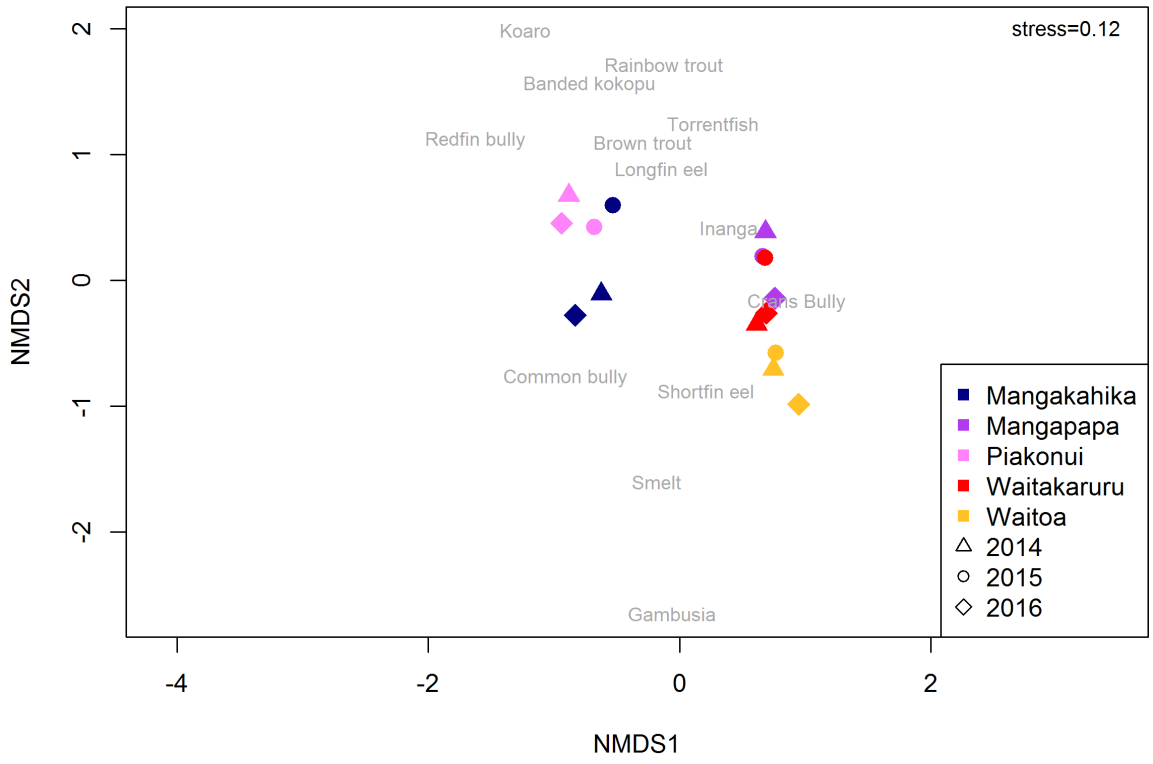

Figure 3-2: Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Piako catchment sites. 'Stress' is a measure of how well the distances on an ordination plot reflect actual 'ecological distance' (i.e., dissimilarity) between different communities in the dataset. Stress values <0.2 are considered an acceptable representation of the data (Clarke and Warwick 2001).

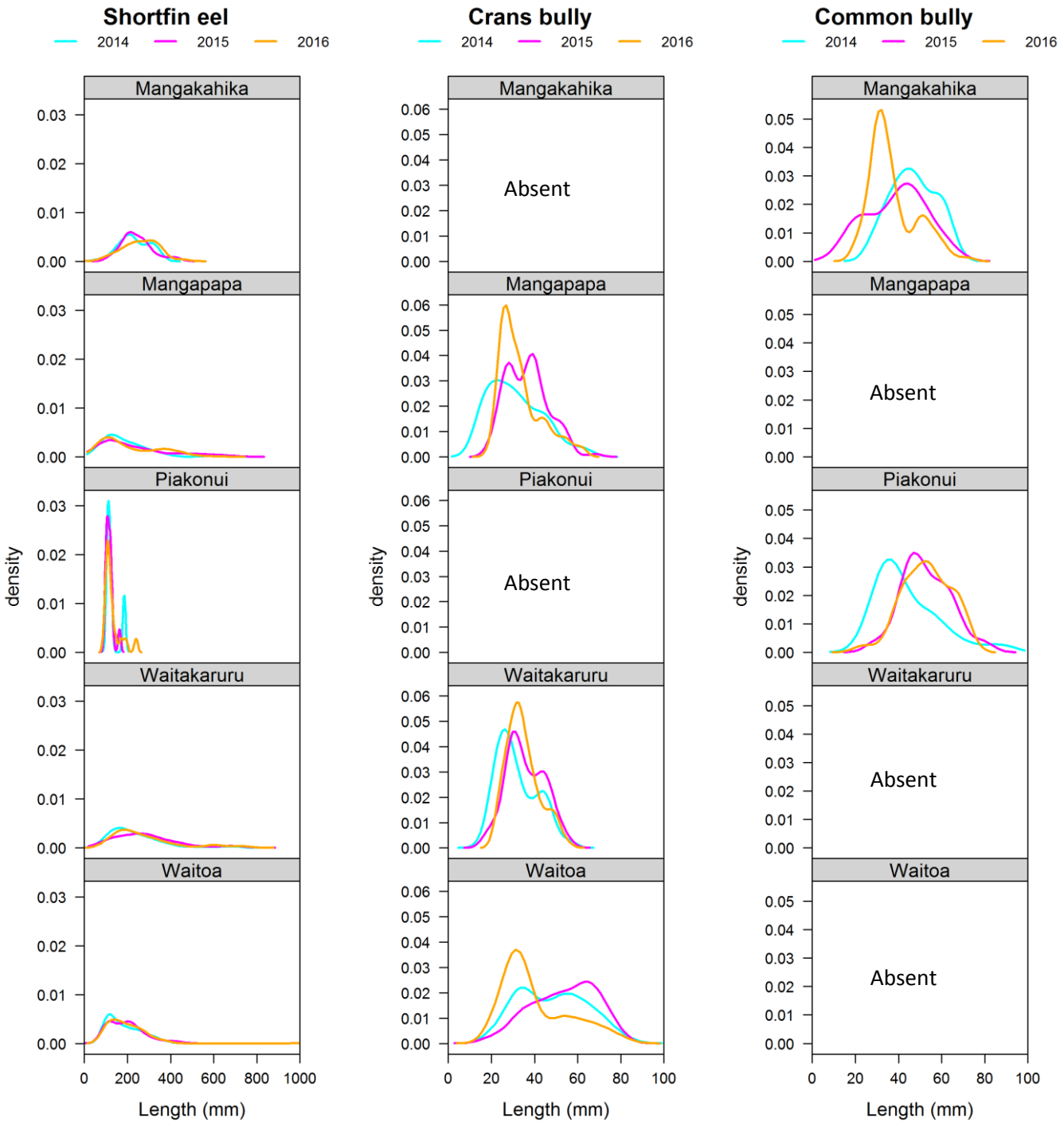

Figure 3-3: Size distributions (probability density functions) for the most abundant fish species at each site in the Piako catchment between 2014 and 2016. 2014 is shown in blue, 2015 is shown in pink, and 2016 is shown in orange.

Table 3-2: Size ranges for most abundant fish (eels and bullies) captured in the Piako catchment in 2014-2016. The results from the 2016 survey are in blue; the results from the 2014 and 2015 surveys are included in black for comparison.

Site	Year	Shortfin eel			Longfin eel			Cran's bully			Common bully		
		min	max	median	min	max	median	min	max	median	min	max	median
1. Mangakahika	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	2016	81	1000	180	330	760	586.5	19	85	34	-	-	-
	2015	95	450	198	-	-	-	20	78	56	-	-	-
	2014	91	395	168	91	880	280	20	85	49	-	-	-
3. Mangapapa	2016	86	590	162	92	520	238.5	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	2016	105	740	226	-	-	-	23	55	33	-	-	-
	2015	87	718	266.5	-	-	-	18	55	35	-	-	-
	2014	90	700	200	90	740	550	15	57	30	-	-	-
5. Piakonui	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

3.1.2 Macroinvertebrates

All sites were sampled according to the MfE protocol C1 for hard-bottomed streams, with an area of approximately 1 m^2 sampled at each site. A full taxonomic list for each site is included in Appendix D and is summarised at the taxa level in Table 3-3 according to the methods and requirements of (Collier and Kelly 2005). Total taxa richness describes the total number of different types of macroinvertebrates present at a site. Broadly speaking, the higher the total taxa richness, the greater the quality and diversity of habitats present. Benthic invertebrates such as Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) 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 types of sensitive species than intensively developed (i.e., pasture) catchments (Boothroyd and Stark 2000). EPT richness and %EPT (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 in 2016 compared to 2015, continuing the increasing trend observed between 2014 and 2015 (Table 3-3). EPT richness was also higher at all sites in 2016 than in 2015, although the relative abundance of EPT only increased in two sites (Mangakahika and Waitakaruru Streams). MCI scores were also higher in all sites excluding Waitoa Stream in 2016, although scores in Mangapapa and Piakonui remained below the 2014 values.

As in 2014 and 2015, the Piakonui site had the highest total taxa richness and EPT richness out of all sites; the %EPT and MCI scores were also highest at this site (Table 3-3). The Mangapapa and Waitakaruru sites were tied for lowest taxonomic richness in 2016 (Table 3-3), although the number of EPT taxa in both sites had increased. The MCI scores also improved in both sites, a reversal of the previous year's decline (Figure 3-4), indicating the presence of more pollution-sensitive taxa. Mangapapa moved from a 'poor' to a 'fair' score, while Waitakaruru moved from 'fair' to 'good.' The MCI score for Mangakahika went from 'fair' to 'excellent.' This improvement is possibly linked to the concurrent improvement in habitat score at this site between 2015 and 2016 (see Figure 3-8). The MCI score in the Piakonui remained in the 'excellent' category, similar to the previous two years (Figure 3-3). The Waitoa site, on the other hand, went from 'excellent' to 'good,' perhaps due to the increase in algal abundance that was also observed at this site in 2016 (see Figure 3-4).

Table 3-3: Summary of macroinvertebrate results for the Piako monitoring sites in 2014-2016. The results from 2016 are in blue; the results from the 2014 and 2015 surveys are included in black for comparison. MCI scores less than 80 are classified as 'poor,' scores 80-100 are 'fair,' scores 100-120 are 'good,' and scores greater than 120 are considered 'excellent' (Stark & Maxted 2007).

Site	Year	Total taxa richness	EPT richness	%EPT	MCI
1. Mangakahika Stream	2016	31	15	40.8	122.6
	2015	27	10	24.1	100
	2014	20	11	58.7	107.0
2. Waitoa Stream	2016	18	12	61.4	112.2
	2015	17	11	77.2	130.6
	2014	15	10	69.9	113.3
3. Mangapapa Stream	2016	17	10	21.7	98.8
	2015	13	8	38.7	76.9
	2014	9	6	2.0	106.7
4. Waitakaruru Stream	2016	17	9	42.8	110.6
	2015	14	7	15.9	94.3
	2014	13	5	38.6	90.8
5. Piakonui Stream	2016	33	23	76.1	134.5
	2015	34	20	86.8	134.1
	2014	28	15	83.5	137.1

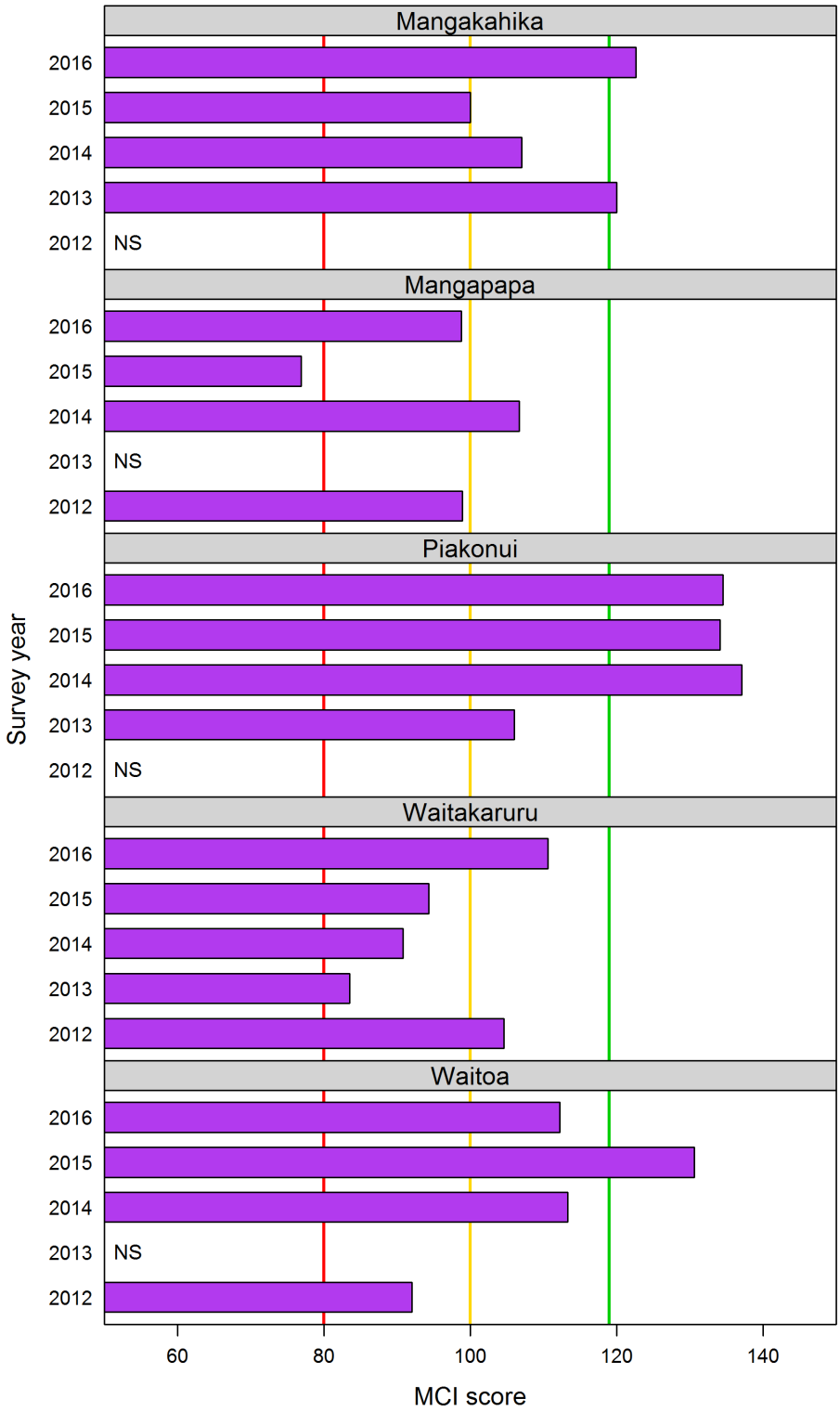

Figure 3-4: Comparison of MCI scores between survey years in the Piako catchment. Vertical lines indicate boundaries for quality classes. Anything below the red line is 'poor', between the red and yellow lines is 'fair', between the yellow and green lines is 'good' and above the green line is 'excellent' (Stark & Maxted 2007). Years in which a site was not surveyed or data is not available are marked 'NS.'

3.1.3 Macrophytes & periphyton

Three of the five sites have no or low macrophyte cover present (Figure 3-5). Macrophyte cover also declined in the other two sites compared to the previous year, from nearly 50% to 20% (similar to the 2014 level) in Waitakaruru Stream and from 30% to 25% in Waitoa Stream (Figure 3-5). The change in the Waitakaruru was largely due to reduced abundance of *Potamogeton crispus*, an exotic submerged macrophyte. The Waitoa site, on the other hand, continued to be dominated by emergent watercress (*Nasturtium officinale*).

The periphyton enrichment (PEI) and sliminess (PSI) indices have remained relatively stable over time at the Piakonui and Mangakahika sites (Figure 3-6 & Figure 3-7). Although the Waitoa had very low periphyton scores in 2015, the higher 2016 scores for PEI and PSI in 2016 were consistent with those observed in 2013 and 2014. In the Waitakaruru, both PEI and PSI scores have declined between 2014 and 2016 (Figure 3-6 & Figure 3-7), indicating that nutrient enrichment has been alleviated at this site. Conversely, the PEI score for Mangapapa Stream in 2016 was nearly double the 2015 score, which had been the highest recorded score for that site to date. The 2016 PSI score for Mangapapa was also approximately twice as large as the 2015 score, though it was much lower (23.2) than the PEI score (90).

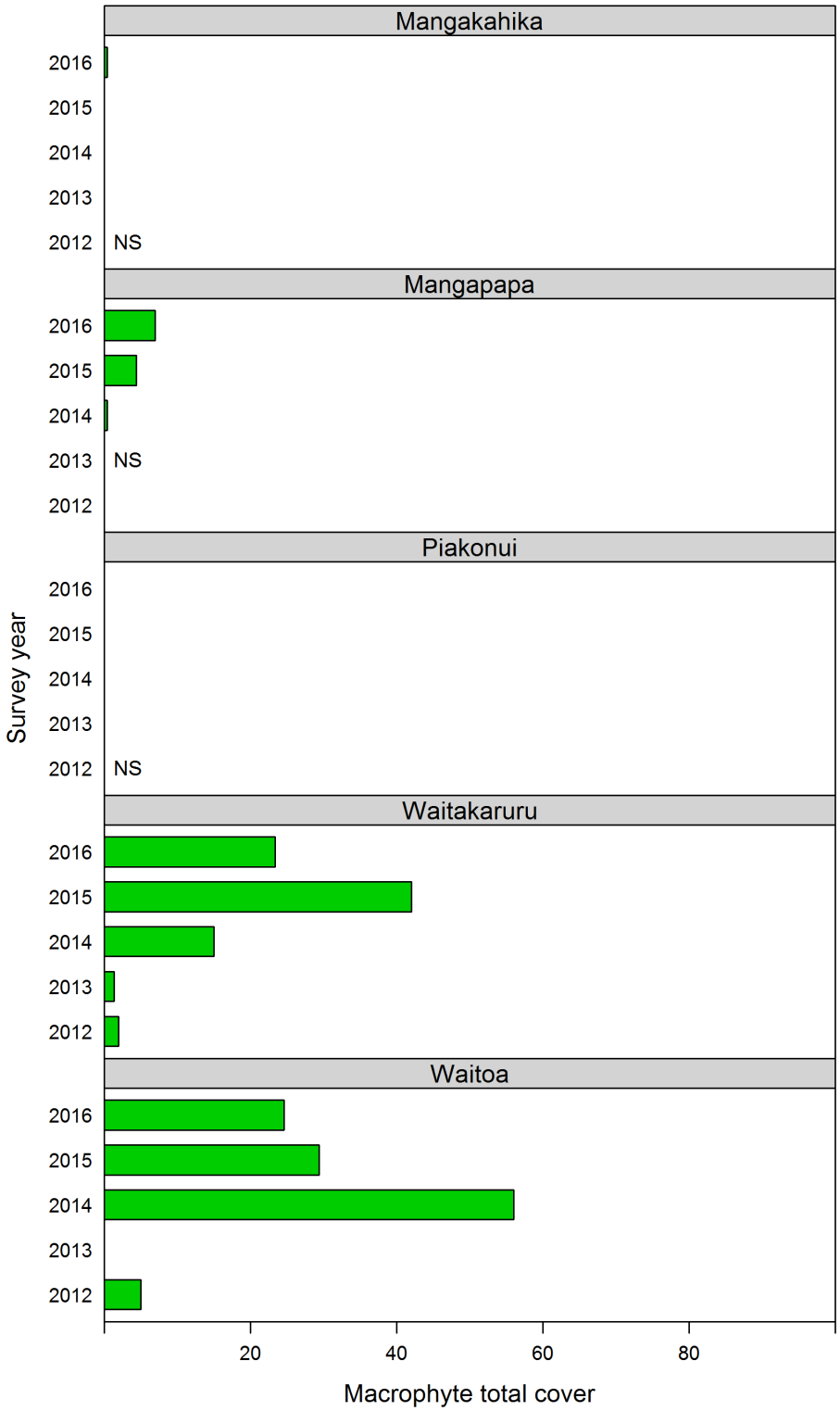

Figure 3-5: Comparison of macrophyte total cover (MTC) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

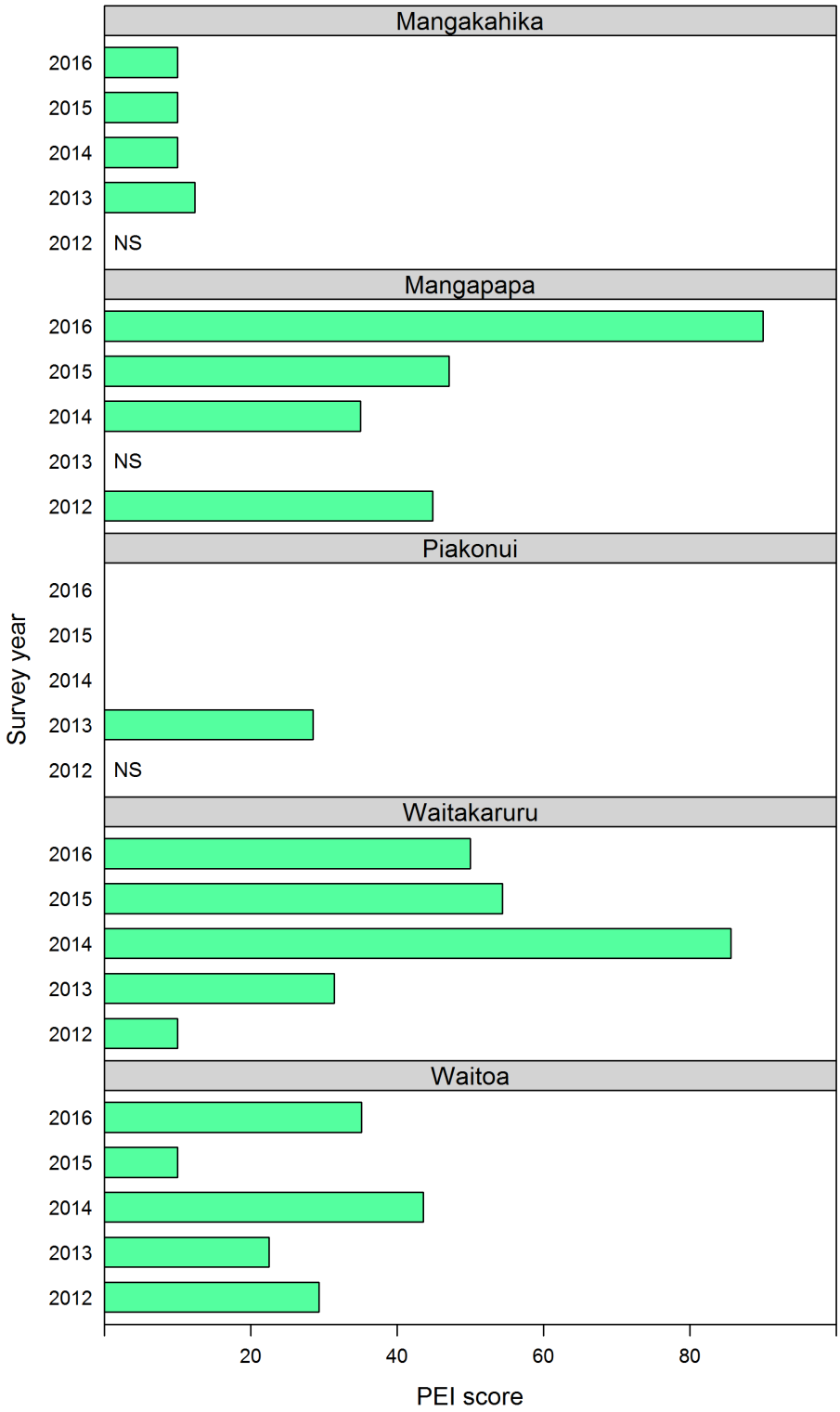

Figure 3-6: Comparison of periphyton enrichment index (PEI) scores over time at the Piako survey sites.
Years in which a site was not surveyed are marked 'NS.'

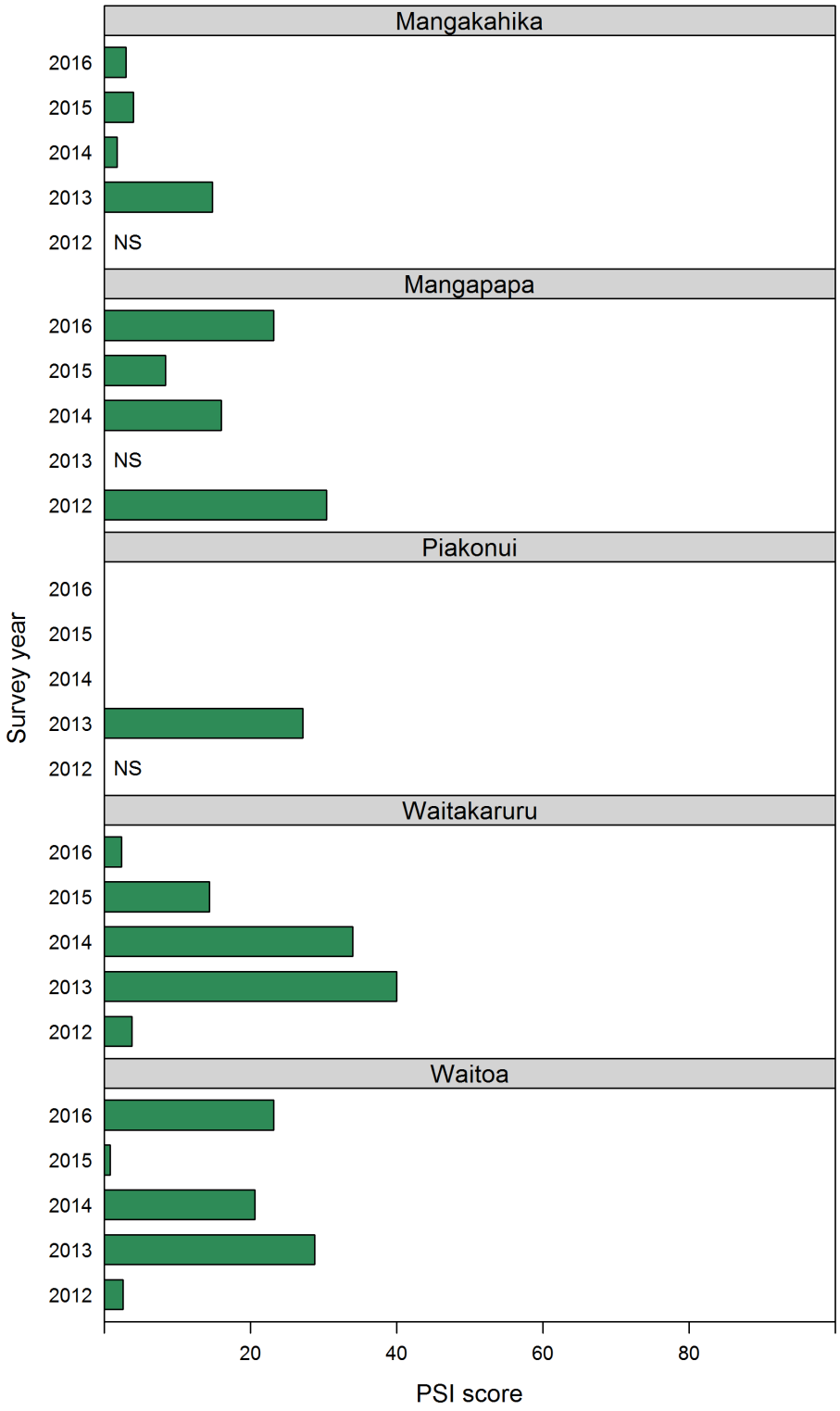

Figure 3-7: Comparison of periphyton sliminess index (PSI) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

3.1.4 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 3-8). However, there has been a gradual decline in scores in the Mangapapa site (Figure 3-8), which lacks adequate fencing to prevent stock from accessing the stream. The lower habitat scores were primarily caused by decreases in riparian vegetation and increased stream bank erosion. The Waitoa site habitat scores were also declining until 2014, improved slightly in 2015, and declined again in 2016. Fencing is also absent at this site, and the variability in scores may reflect access and damage by livestock. Habitat scores for Mangakahika and Waitakaruru streams had decreased in 2015, but increased again in 2016, likely in association with increased bank stability and reduced sediment deposition, as well as lower periphyton cover. Piakonui stream had a slightly higher habitat score in 2016 than 2015, continuing a positive trend observed since 2013. Improved scores in this site are related to continued growth of riparian buffers as well as increased bank stability and reduced sediment deposition.

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=21). 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=0.45; Figure 3-9). Interestingly, the correlation appears to have been stronger in the early surveys (2012-2014), whereas in 2015 and 2016 higher MCI scores were observed even in sites with low habitat scores. Nonetheless, the highest MCI scores were found in the site which also had the highest habitat score, Piakonui Stream (Figure 3-8). The correlations between habitat score, total macroinvertebrate richness and fish species richness were also modest but positive (ρ=0.44 for both; Table 3-4). The strongest correlation was between fish richness and habitat score (ρ=0.47), indicating that fish may be more influenced by in-stream physical habitat conditions than invertebrates (Figure 3-10, Table 3-3).

Table 3-4: Correlation coefficients between the habitat score and various biotic indices for the Piako catchment in 2016.

Biotic index	Spearman's rank correlation coefficient
MCI	0.45
Macroinvertebrate total richness	0.44
EPT richness	0.44
% EPT	0.33
Fish richness	0.47

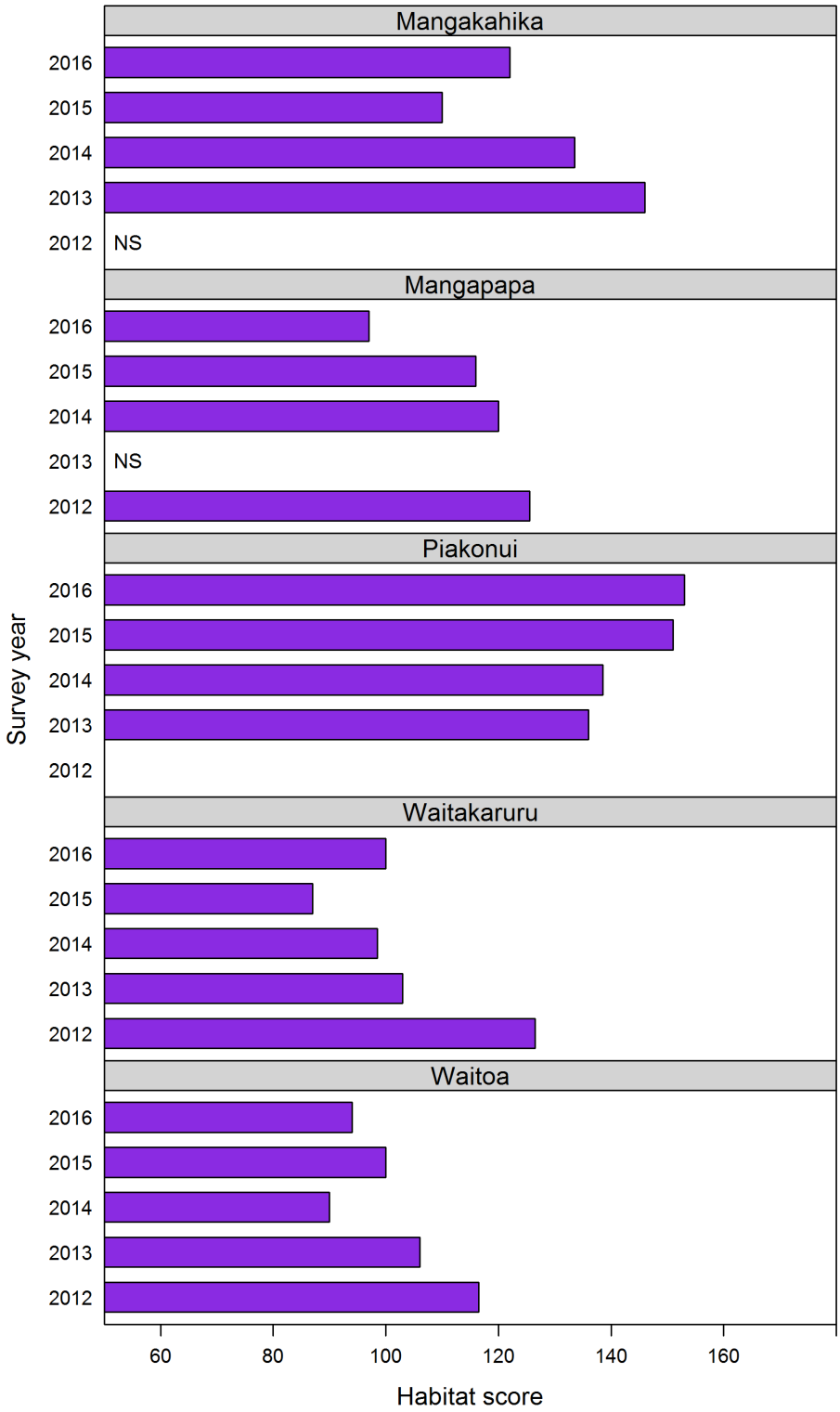

Figure 3-8: Comparison of habitat scores over time for the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

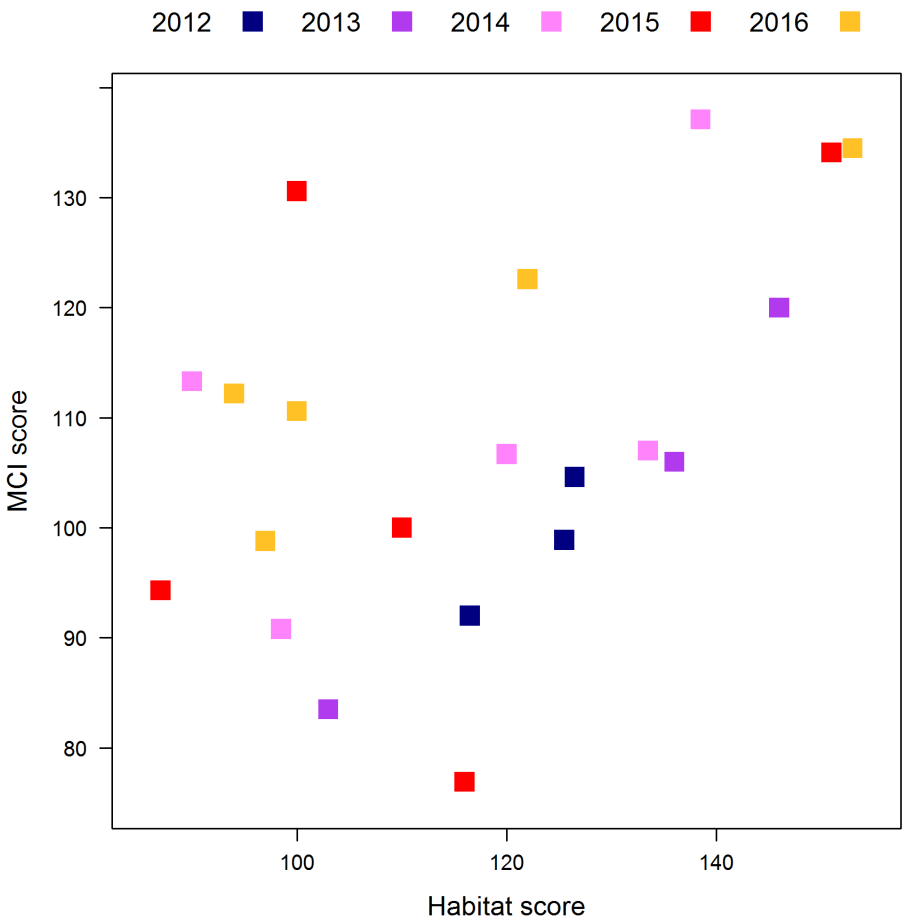

Figure 3-9: Scatterplot of habitat score against MCI score at the Piako survey sites in different survey years (ρ=0.45). No MCI score was available for the Waitoa site in 2013.

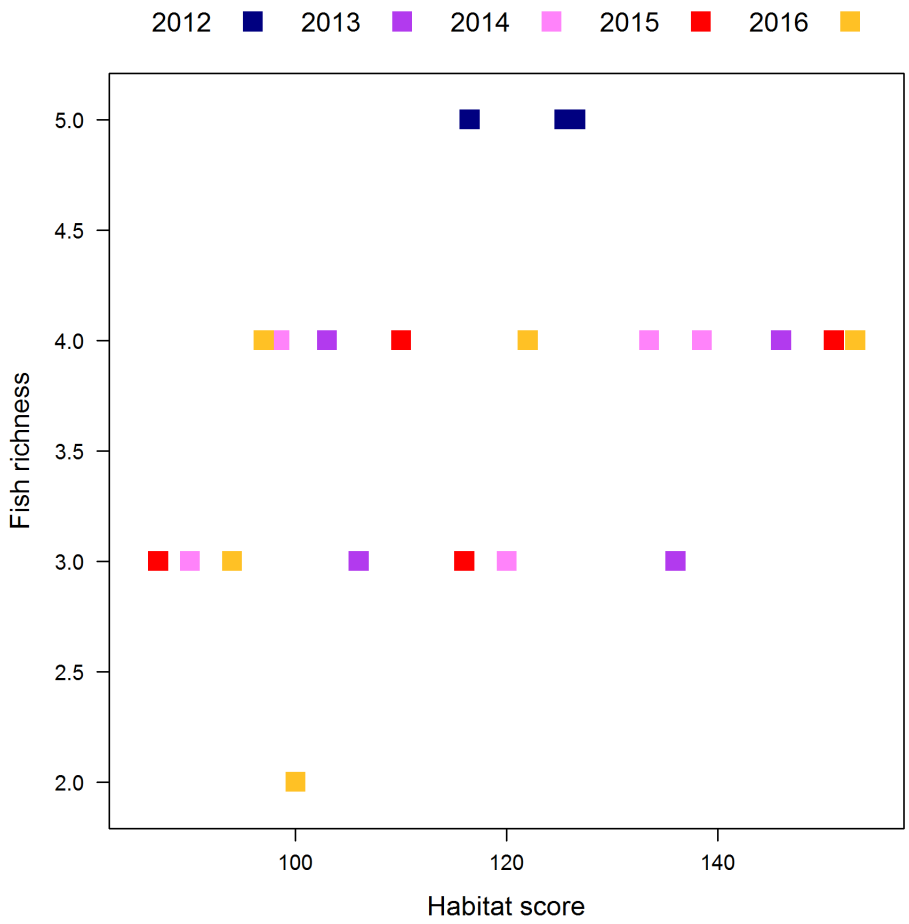

Figure 3-10: Scatterplot of habitat score against fish species richness at the Piako survey sites in different survey years (ρ=0.47).

3.2 Waihou catchment

3.2.1 Fish

Twelve different fish species were recorded among the five Waihou survey sites in 2015, nine 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, while longfin eels were recorded at four sites. Koura (freshwater crayfish), were also present at all five sites and freshwater shrimp (*Paratya curvirostris*) were found at one site. Banded kokopu were only captured at one site, similar to 2015, although it was a different site. Inanga were also only found at one site, compared to two sites in 2015. Redfin bully were captured for the first time in any of the sampled Waihou or Piako streams, as was *Gambusia affinis*, the invasive mosquitofish. The greatest species richness (8 total, including 6 native species and 2 exotic species) was recorded in the Karengorengo survey site, where shortfin eels, longfin eels, Cran's bully, torrentfish, inanga, banded kokopu, rainbow trout (*Oncorhynchus mykiss*), and brown trout (*Salmo trutta*) were captured (Table 3-5). This is lower than the maximum richness of eight species observed at the Paiakarahi site in 2015 (only four taxa were captured at that site in 2016). The greatest abundance of fish was recorded from the Wairere Stream site, due to high numbers of common bullies and shortfin eels, although Karengorengo Stream had the greatest abundance of shortfin eels alone.

The total and relative abundance of fish is compared between survey years for each site in Figure 3-11. A high abundance of macrophytes at the Karengorengo Stream site severely inhibited electric fishing in 2014; it was suspected that the low abundances recorded that year were underestimates caused by the low capture efficiency. Macrophyte cover at this site has continued to decrease over time, to the lowest level observed in 2016 (Figure 3-15). The numbers of fish captured have increased correspondingly in the past two years, with the greatest number of bullies and shortfin eels found in 2016. However, the reduced macrophyte cover was not associated with increased capture of longfin eels or inanga (one present in 2015 and 2016), both of which were found in greater abundance in surveys prior to 2014. A new exotic species, *Gambusia*, was also captured for the first time in this site in 2016, although it is possible it has been present in all sampling years but was not found due to the electric-fishing difficulties.

At the Paiakarahi sampling site, the abundance of shortfin eels, torrentfish, and brown trout were consistent with ranges observed in the previous two surveys (Figure 3-11, Table 3-5). Abundance of Cran's bullies was greater than that observed in 2015, and similar to 2014 numbers. However, inanga and banded kokopu, both of which were found in low numbers in previous surveys, were not captured in 2016, nor were rainbow trout, which were also present in 2014 and 2015.

At the Wairere Stream site, the relative abundances of both shortfin and longfin eels in 2016 were similar to those observed in 2015 (Figure 3-11, Table 3-5). Greater numbers of common bullies were caught in 2016 compared to 2015, although the relative abundance was still much less than in 2014. Torrentfish abundance increased in 2016, while inanga continued to be absent (only recorded in the 2011 survey).

At the Waitearikiki survey site, fewer shortfin and longfin eels were recorded in 2016 compared to 2015 (Figure 3-11, Table 3-5). Cran's bully abundance, on the other hand, was higher in 2016 than in 2015. There was also a greater abundance of torrentfish. Unlike previous years, no trout were captured. Banded kokopu were also recorded again after not being captured in 2015.

At the Waitawheta site, shortfin and longfin eel abundances have shown a continued decline since 2014, whereas common bully abundance was the highest recorded in 2016. Brown trout, which had been present in 2014 and 2015, were not captured, but one rainbow trout was recorded. No banded kokopu were captured (last observed in 2014). Koura abundance was lower than in 2015, but comparable with the 2014 level.

Community composition was similar among the five Waihou sites, and also did not vary widely within each stream, except for in Karengorengo Stream, in which there were large shifts in assemblage composition between years (Figure 3-12). These shifts are likely associated with the substantial reduction in macrophyte cover during this period. This could reflect either changes in composition related to changes in macrophyte cover or, more likely, simply be an artefact of the improvement in electric-fishing efficiency in low macrophyte conditions. There was also a shift in community composition in Wairere Stream between 2014 and 2015, while the 2016 community was again very similar to the 2014 assemblage. The community in Waitawheta Stream has moved in the same direction on the ordination over the three survey years, perhaps indicating a directional trend.

Size distributions show that shortfin eel population structure has remained consistent over time in Karengorengo, Paiakarahi, and Wairere Streams (Figure 3-13). As in the Piako streams, shortfin eel size distributions tended to be right-skewed with a greater proportion of small eels (median size 123-187 mm across the five sites; Table 3-6). There were very few large shortfin eels >400 mm at any site. In fact, in Waitawheta there were no large eels >250 mm. This may indicate lack of suitable habitat for large eels within this site or high fishing pressure. In Waitearikі Stream there were also high numbers of small (<200 mm) eels, indicating increased recruitment, but few medium-sized (200 mm – 400 mm in length) eels, perhaps due to the migration of adult males to sea. The few longfin eels captured at these sites were all much larger (>300 mm, Table 3-6), suggesting that instream habitat may be more suited to longfin eels (i.e., hard substrate) rather than shortfin eels. On the other hand, the scarcity of longfin elvers (no longfin eels <200 mm caught in 2016 and only 3 in 2015) suggests that either recruitment of longfin eels in these streams has been poor in recent years, or it could represent an artefact of the limited sampling, as longfin elvers tend to have a patchy distribution.

Bully distributions were more normal with little skew. However, the peak of the distribution shifted between years within sites, and was bimodal in multiple years, indicating high proportions of small and large fish but few median-sized individuals. There were fewer small (<30 mm) bullies of both species in 2016 than 2015 in all but one site (Wairere), indicating less recruitment of juveniles (Figure 3-13). This is the opposite of the pattern observed in 2015, when there were more small fish, indicating increased recruitment, and less large fish. This suggests that there are natural inter-annual variations in recruitment in these populations.

Table 3-5: Results of 2014-2016 electric fishing surveys at the five Waihou catchment monitoring sites. A = Number caught (abundance); RA = Relative abundance (individuals per 100 m^2). The results from 2016 are in blue; the results from the 2014 and 2015 surveys are included in black for comparison.

Site	Year	Shortfin eel		Longfin eel		Elver		Cran's bully		Common bully		Redfin bully		Torrent-fish		Inanga		Smelt		Gambusia		Banded kokopu		Rainbow trout		Brown trout		Unid. trout		Koura		Paratya	
		A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA
6.	2016	8	1.4	-	-	-	-	61	10.5	-	-	-	-	3	0.5	-	-	-	-	-	-	-	-	-	-	1	0.2	-	-	5	0.9	-	-
Paiakarahi	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	3	0.7
	2014	8	1.6	8	1.6	-	-	64	13	-	-	-	-	5	1	1	0.2	-	-	-	-	1	0.2	3	0.6	-	-	-	-	32	6.5	-	-
7.	2016	360	103.4	1	0.3	-	-	-	-	25	7.2	-	-	-	-	1	0.3	13	3.7	1	0.3	-	-	-	-	-	-	-	-	75	21.6	-	-
Karengorengo	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.	2016	120	16	1	0.1	16	2.1	-	-	293	39.1	-	-	7	0.9	-	-	-	-	-	-	-	-	-	-	1	0.1	-	-	35	4.7	8	1.1
Wairere	2015	148	17.5	1	0.1	34	4	-	-	208	24.6	-	-	2	0.2	-	-	-	-	-	-	-	-	3	0.4	5	0.6	-	-	15	1.8	6	0.7
	2014	254	31.1	2	0.3	-	-	-	-	965	118	-	-	1	0.1	-	-	-	-	-	-	-	-	-	-	1	0.1	-	-	58	7.1	-	-
9.	2016	28	2.2	4	0.3	-	-	173	13.4	-	-	-	-	7	0.5	-	-	-	-	-	-	5	0.4	-	-	-	-	-	-	120	9.3	-	-
Waitearikl	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.	2016	8	1.3	3	0.5	-	-	-	-	96	15.3	15	2.4	-	-	-	-	-	-	-	-	-	-	1	0.2	-	-	-	-	10	1.6	-	-
Waitawheta	2015	12	2.9	17	4	-	-	-	-	53	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	-	-	25	6	-	-
	2014	23	4.5	16	3.1	-	-	-	-	64	12.6	-	-	-	-	-	-	-	-	-	-	1	0.2	-	-	3	0.6	-	-	10	2.0	-	-

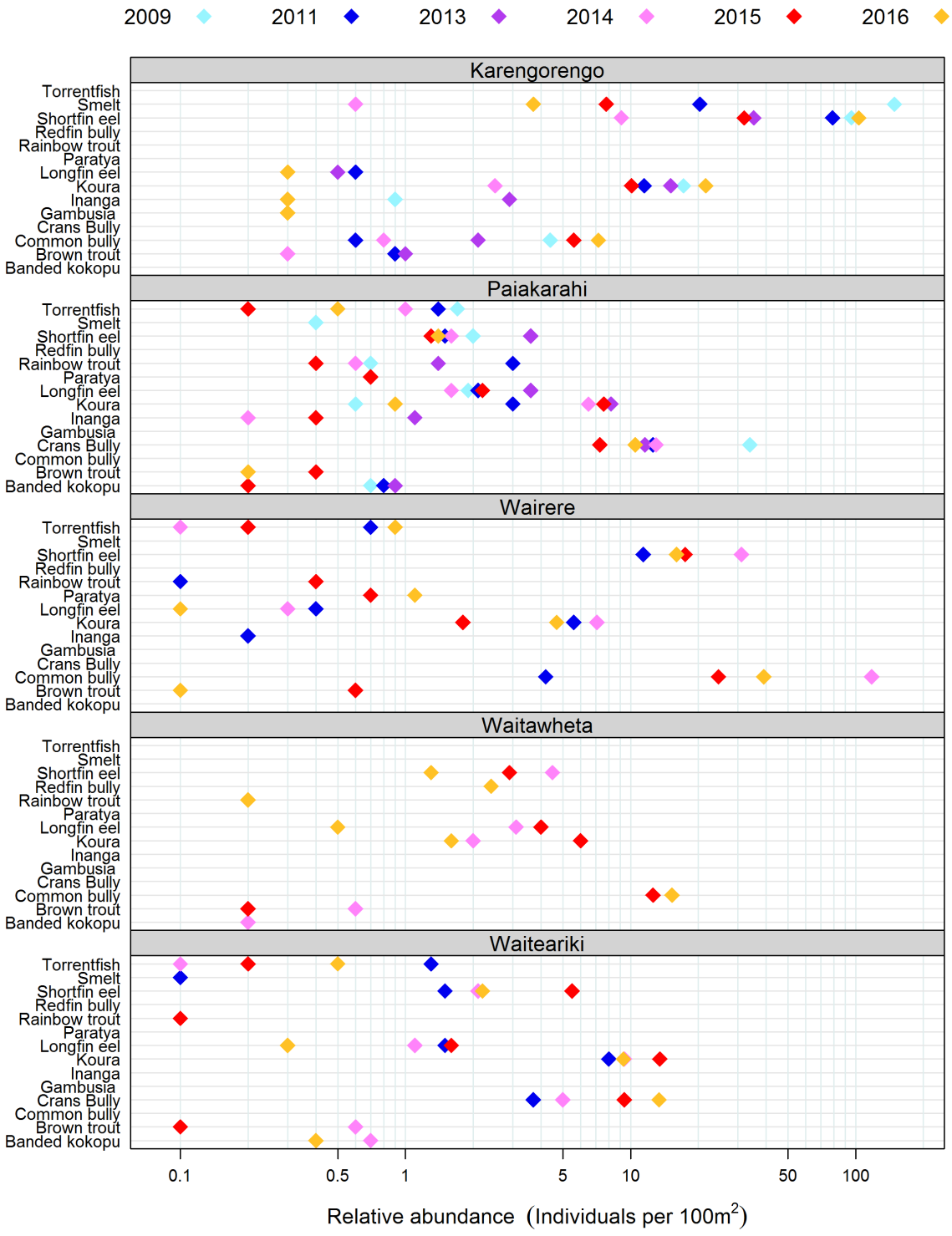

Figure 3-11: Comparison between the relative abundance of fish captured in the 2009, 2011, and 2013 - 2016 Waihou surveys. Wairere Stream and Waiteariki Stream were only sampled in 2011 and 2014-2016. The Waitawheta was only sampled in 2014-2016. Note the logarithmic x-axis.

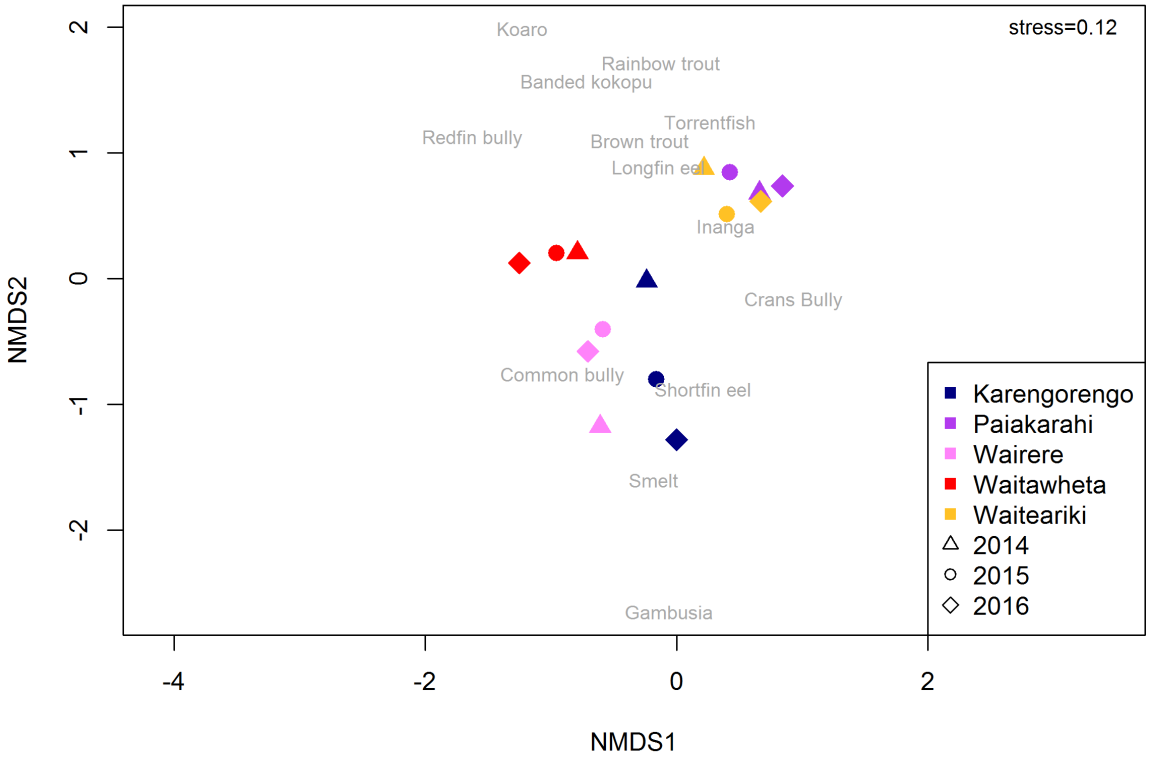

Figure 3-12: Nonmetric multidimensional scaling (NMDS) ordination plot showing fish assemblage composition over time in the Waihou catchment sites. 'Stress' is a measure of how well the distances on an ordination plot reflect actual 'ecological distance' (i.e., dissimilarity) between different communities in the dataset. Stress values <0.2 are considered an acceptable representation of the data (Clarke & Warwick 2001).

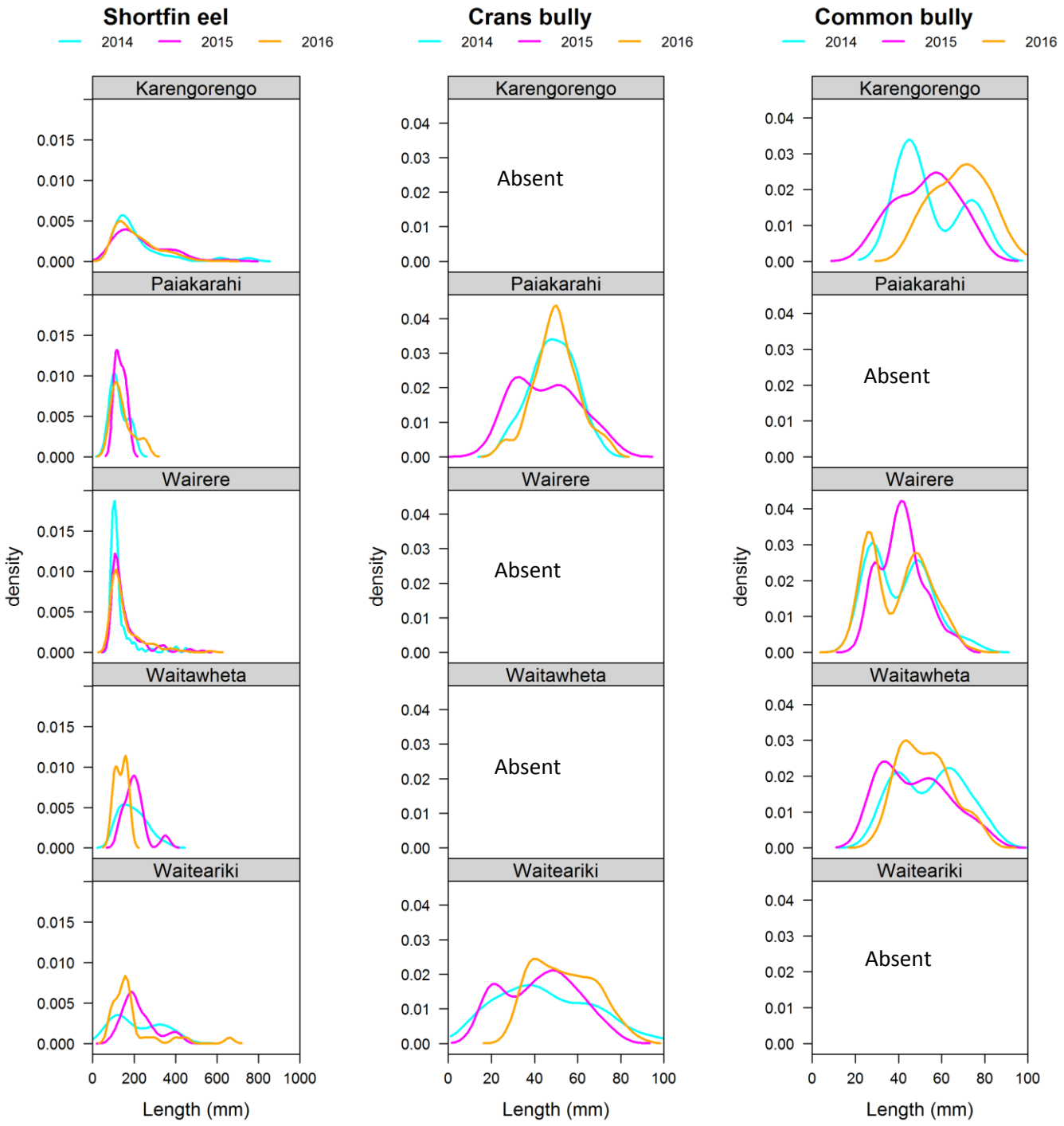

Figure 3-13: Size distributions (probability density functions for the most abundant fish species at each site in the Waihou catchment between 2014 and 2016. 2014 is shown in blue, 2015 is shown in pink, and 2016 is shown in orange.

Table 3-6: Size ranges for most abundant fish (eels and bullies) captured in the Waihou catchment in 2014-2016. The results from the 2016 survey are in blue; the results from the 2014 and 2015 surveys are included in black for comparison.

Site	Year	Shortfin eel			Longfin eel			Cran's bully			Common bully		
		min	max	median	min	max	median	min	max	median	min	max	median
6. Paiakarahi	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	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	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	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	2016	100	173	139	345	470	350	-	-	-	30	81	52
	2015	132	351	195	205	710	360	-	-	-	30	80	46
	2014	115	350	190	250	750	350	-	-	-	30	85	57.5

3.2.2 Macroinvertebrates

Taxa richness was lower in 2016 than in 2015 at the Paiakarahi, Karengorengo and Wairere sites and showed no change at the Waiteariki site. However, the taxa richness values in 2015 were the highest ever recorded for four of the five sites, and the 2016 scores were on par with those observed in 2014 (Table 3-7). EPT richness was also lower than in 2015 but higher than in 2014 at the Wairere and Paiakarahi sites, and remained the same at the Karengorengo site. The percentage of EPT was lower in 2016 in Paiakarahi Stream and Wairere Stream, but remained similar to previous years in Karengorengo and Waiteariki Streams. The Waitawheta Stream was the only site to show increased taxa richness, EPT richness and percent EPT from 2015 to 2016 (Table 3-5).

Despite the decreases in taxa and EPT richness, however, MCI scores were higher in all sites in 2016 than 2015, indicating increased prevalence of pollution-sensitive species (Figure 3-14). The MCI score for Karengorengo improved from 'fair' to 'good' while MCI scores for Paiakarahi, Wairere, and Waiteariki went from 'good' to 'excellent.' Waitawheta stream remained in the 'excellent' category as well.

The higher MCI score for Karengorengo Stream in 2016 may be associated with the large decrease in macrophyte cover which also occurred between the 2015 and 2016 samplings (Figure 3-15). Macrophytes have been shown to influence invertebrate community composition in streams, including increased dominance by pollution-tolerant taxa such as chironomids (Collier 2004) and/or gastropods, particularly *Potamopyrgus* snails (Jaschinski et al. 2010; Graham et al. 2015b). Improved MCI scores may also be attributed to decreased periphyton cover, as in Paiakarahi Stream, which had over a 50% decline in both PEI and PSI between 2015 and 2016. However, the MCI score also improved in Waiteariki stream, which had increased periphyton cover in 2016, indicating that periphyton cover is not the main factor driving changes in MCI scores.

Table 3-7: Summary of macroinvertebrate results for the Waihou monitoring sites in 2014-2016. The results from 2016 are in blue; the results from the 2014 and 2015 surveys are included in black for comparison. MCI scores less than 80 are classified as 'poor,' scores 80-100 are 'fair,' scores 100-120 are 'good,' and scores greater than 120 are considered 'excellent' (Stark & Maxted 2007).

Site	Year	Total taxa richness	EPT richness	%EPT	MCI
6. Paiakarahi Stream	2016	19	13	43.0	122.1
	2015	32	19	61.6	111.3
	2014	18	9	50.2	105.6
7. Karengorengo Stream	2016	18	7	25.7	105.6
	2015	22	7	22.1	82.7
	2014	18	7	22.1	97.8
8. Wairere Stream	2016	18	12	30.1	124.4
	2015	32	20	51.2	116.8
	2014	17	10	35.2	101.2
9. Waitearikl Stream	2016	26	16	72.7	120
	2015	26	13	74.2	111.5
	2014	29	20	78.3	117.2
10. Waitawheta River	2016	33	26	42.9	138.8
	2015	31	22	25.6	134.2
	2014	29	21	23.5	125.5

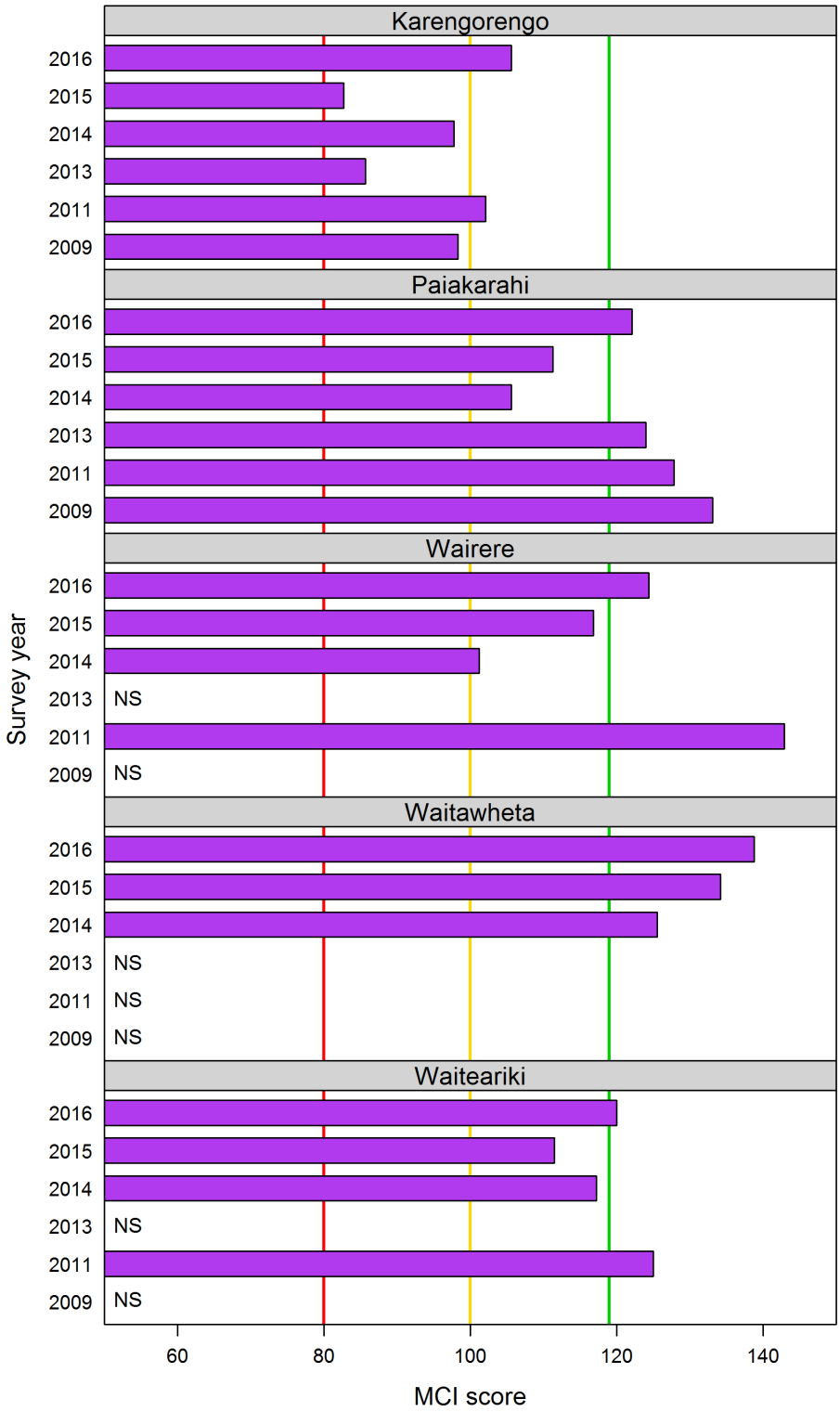

Figure 3-14: Comparison of MCI scores between survey years in the Waihou catchment. Vertical lines indicate boundaries for quality classes. Anything below the red line is 'poor', between the red and yellow lines is 'fair', between the yellow and green lines is 'good' and above the green line is 'excellent' (Stark & Maxted 2007). Years in which a site was not surveyed are marked 'NS.'

3.2.3 Macrophytes & periphyton

Macrophyte cover was low at all the Waihou survey sites in 2016, including Karengorengo Stream, which has had high coverage in previous years (Figure 3-15). Small amounts of macrophyte cover (<10%) were recorded for the first time in Waitawheta and Waiteariki Streams and for the first time since 2011 in Wairere Stream. Continued monitoring will show if this is an increasing trend.

Periphyton enrichment scores (PEI) were lower than 2015 in the Paiakarahi, Wairere, and Waitawheta sites and higher in the Karengorengo and Waiteariki sites (Figure 3-16). The increase in periphyton in Karengorengo Stream is likely correlated with the decrease in macrophyte cover; extensive macrophyte beds probably out-shaded benthic periphyton in previous years. The PSI score, however, only increased slightly in both Karengorengo and Waiteariki Streams (Figure 3-17), indicating that the new growth was thin film algae rather than long filamentous algae. Wairere Stream and Waitawheta Stream showed the opposite pattern; PEI scores were lower than 2015 but PSI scores were higher, indicating greater relative abundance of long filamentous algae. Paiakarahi Stream, on the other hand, had a lower PSI score as well as a lower PEI score in 2016 compared to 2015, indicating reduced algal growth overall.

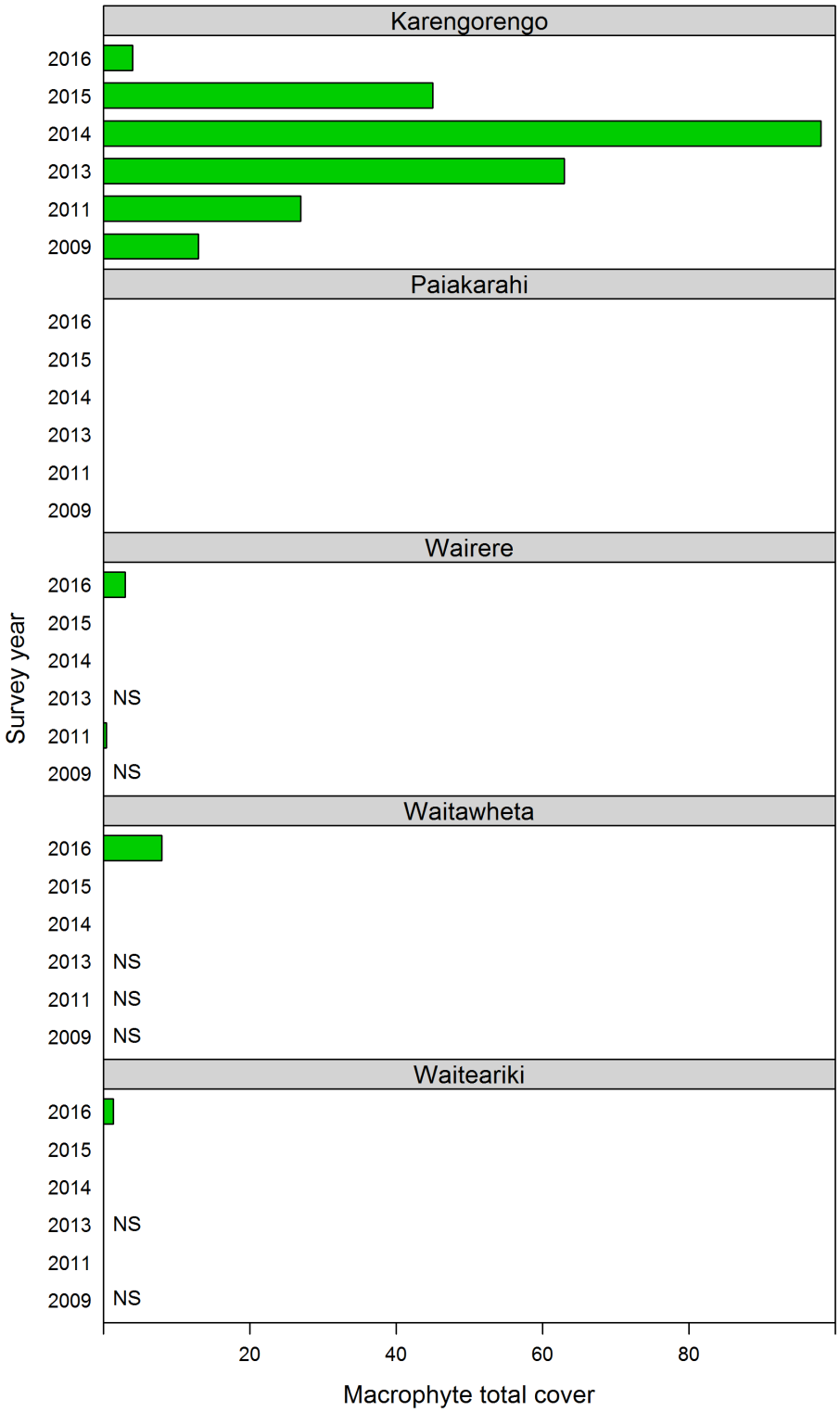

Figure 3-15: Comparison of macrophyte total cover (MTC) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

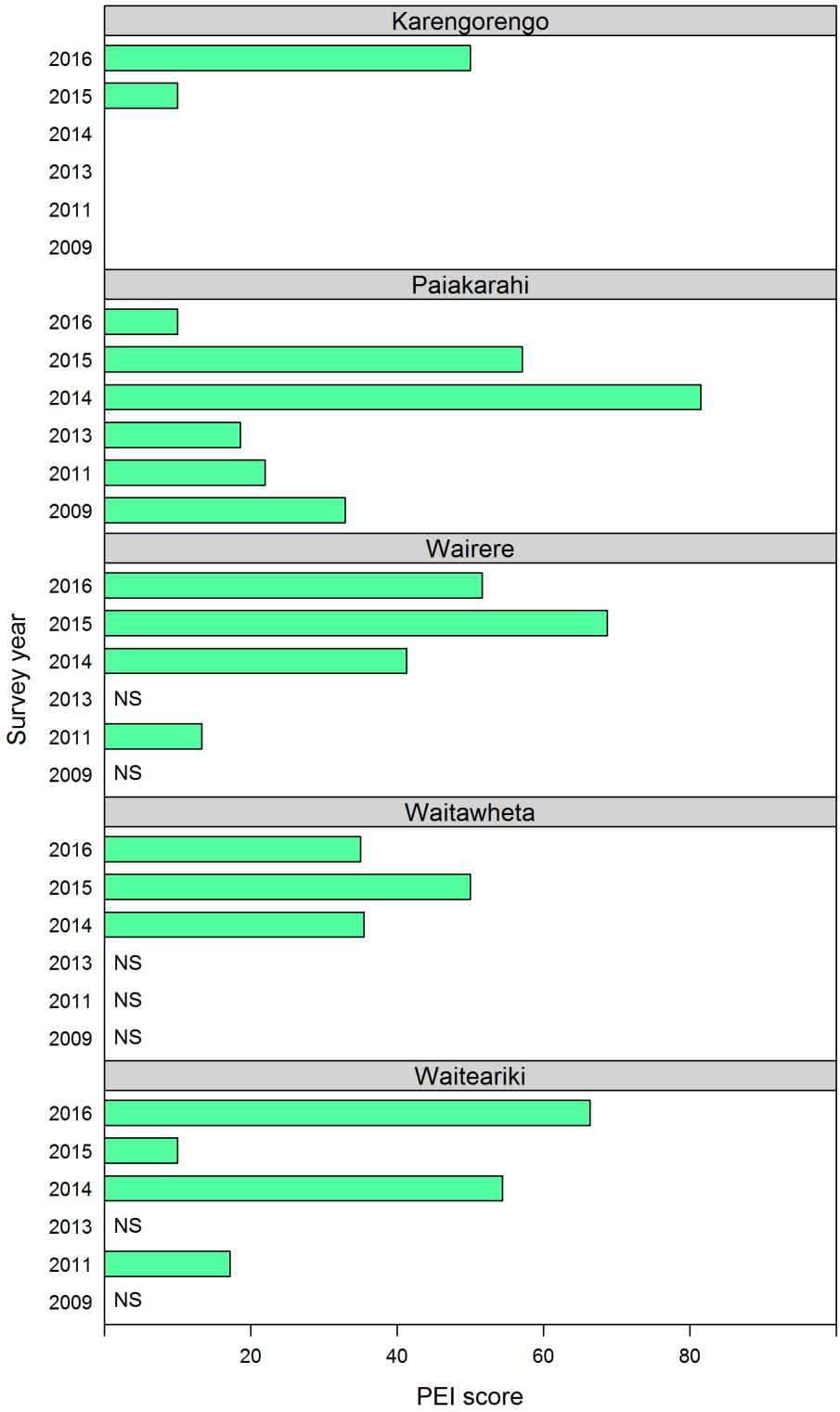

Figure 3-16: Comparison of periphyton enrichment index (PEI) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

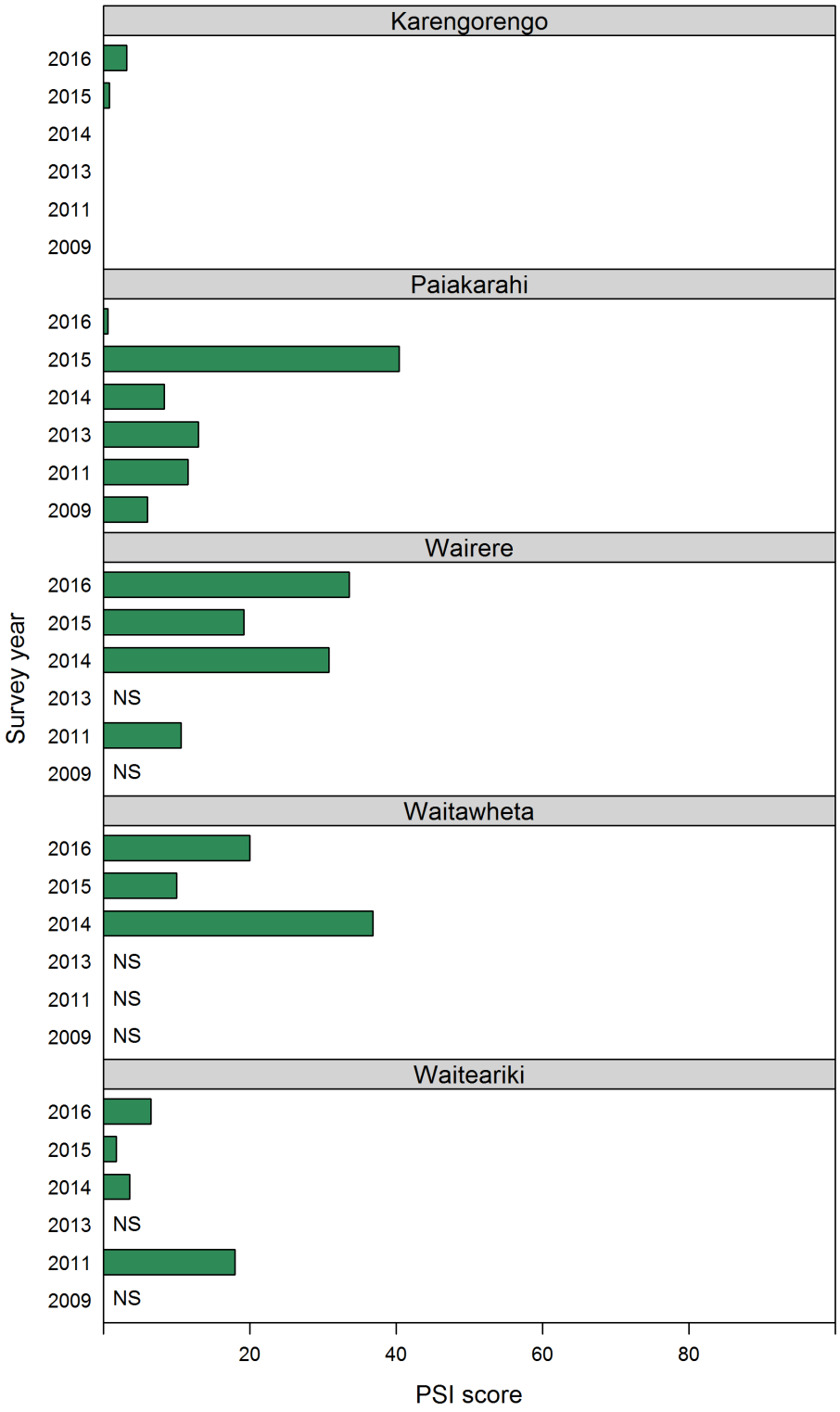

Figure 3-17: Comparison of periphyton sliminess index (PSI) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

3.2.4 Habitat quality scores

The habitat quality scores have fluctuated over time at all of the Waihou survey sites, but remain largely within the same range (Figure 3-18). Waitawheta Stream is the only site with a constant trend over time; the habitat score in this site has been increasing since 2014. The other four sites also showed slight increases in habitat score between 2015 and 2016. In Karengorengo Stream, however, the habitat score remains lower than all other previous samplings except 2015. The decline in habitat score between 2014 and 2015 was associated with increased stream bank erosion, and this year's sampling indicated that recovery has been slow.

Correlations between 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=0.42; %EPT ρ=0.69) (Table 3-8 & Figure 3-19). There was also a positive correlation between fish species richness and habitat score at the Waihou sites (ρ=0.36; Figure 3-20), 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 between the 2015 and 2016 samplings.

Table 3-8: Correlation coefficients between the habitat score and various biotic indices for the Waihou catchment in 2016.

Biotic index	Spearman's rank correlation coefficient
MCI	0.42
Macroinvertebrate total richness	0.37
EPT richness	0.44
% EPT	0.69
Fish richness	0.36

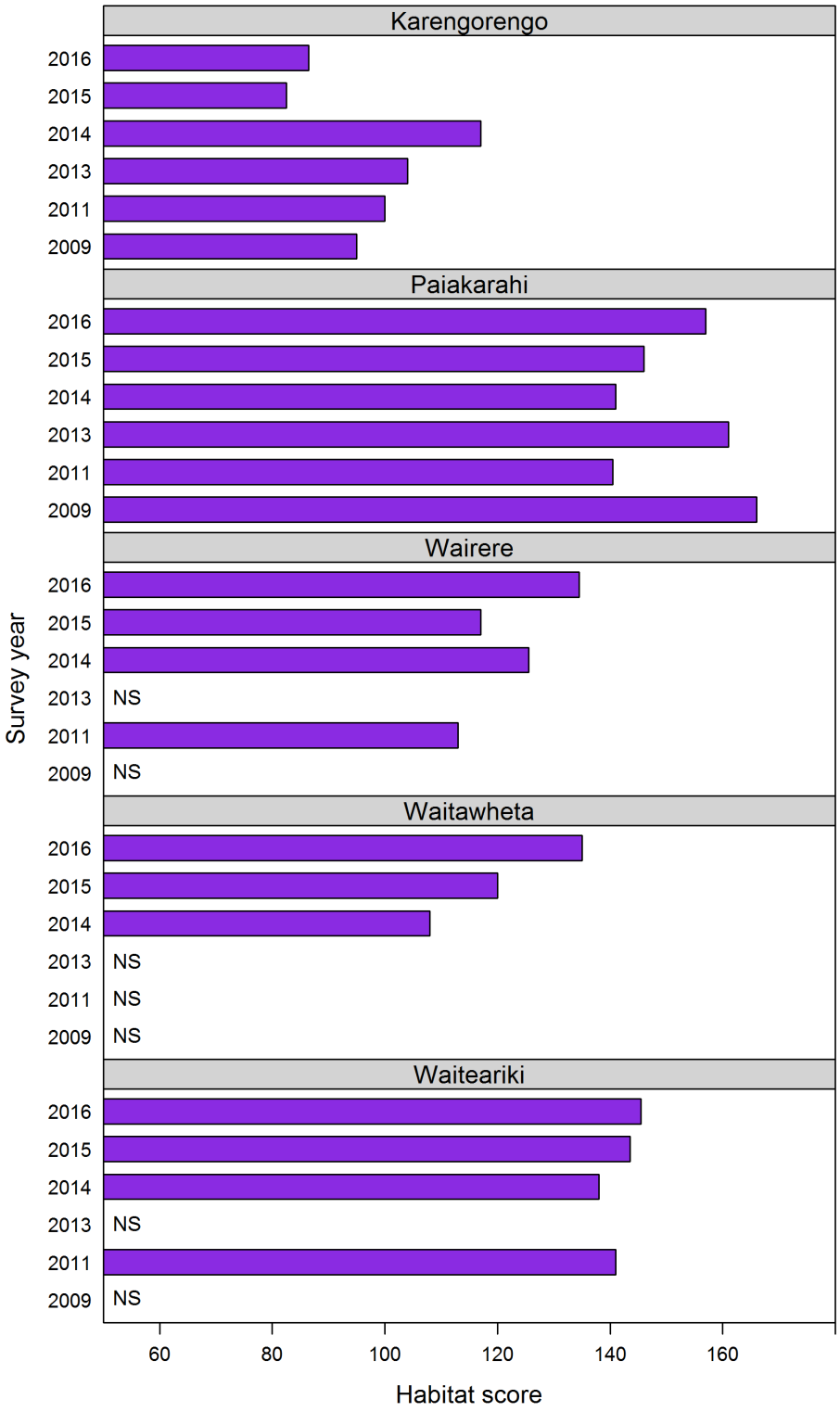

Figure 3-18: Comparison of habitat scores over time for the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

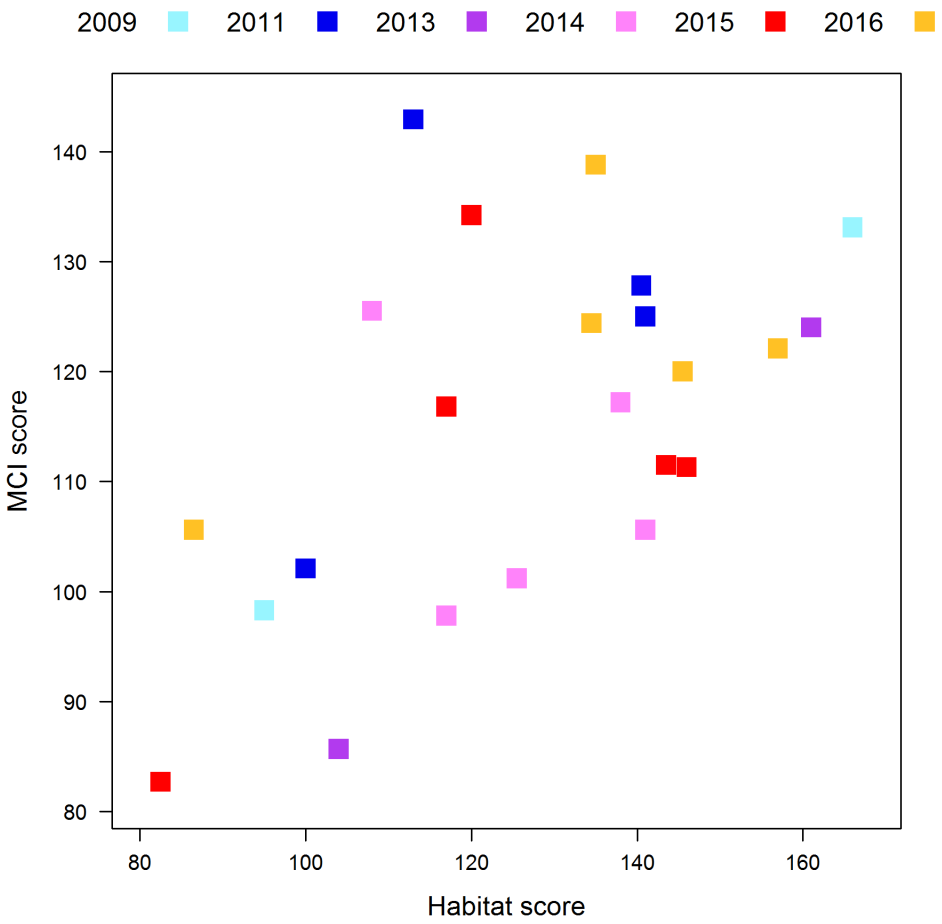

Figure 3-19: Scatterplot of habitat score against MCI score at the Waihou survey sites in different survey years (ρ=0.42).

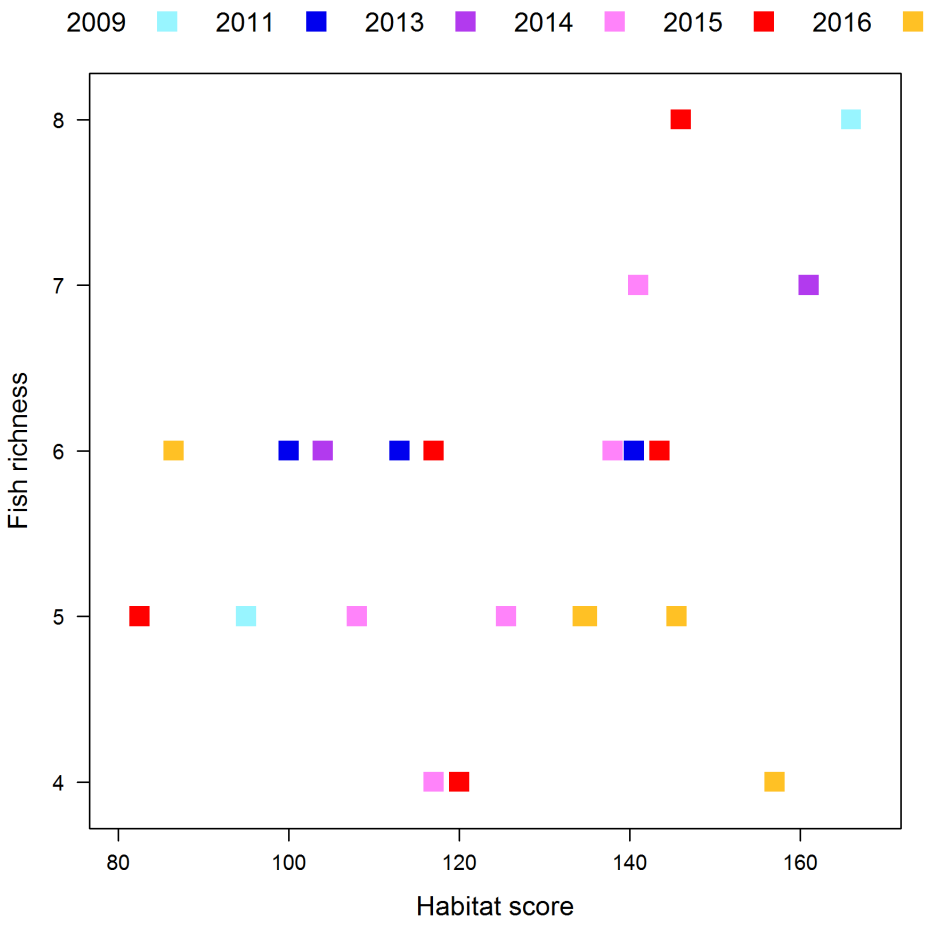

Figure 3-20: Scatterplot of habitat score against fish species richness at the Waihou survey sites in different survey years (ρ=0.36).

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 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. Franklin et al. (2013) proposed five sites in each of the Waihou and Piako catchments where annual ecological monitoring should take place with the aim of supporting the water allocation decision making process. This recommendation was based on attaining a compromise between spatial coverage of the catchments and characterising natural inter-annual variations in the biotic communities. The ten sites are representative of a range of river types typical of each catchment (i.e., lowland, upland, more modified, less modified, different tributaries), with the aim of providing a broad catchment scale overview of ecological status. These ten sites have now been monitored for three years (2014 – 2016), and all but one (Waitawheta) of the selected sites were also surveyed in either 2009, 2011, or 2013 (or a combination of those years).

4.1 Piako catchment

The results of the present survey indicate that at the Piako catchment sites, the relative abundance of fish was generally higher in 2016 than 2015, but not greater than in other previous survey years. Inanga were found for the first time since 2012 in one site, Mangapapa Stream (although they were also present in Waitoa Stream in 2012). The recurrence of inanga in Mangapapa Stream may reflect the increased downstream connectivity or changes in habitat availability associated with the higher summer flows which occurred in 2015-2016, compared to past years. If so, this finding is a positive indication that inanga can recolonise reaches previously disconnected by low flows. The presence of another native fish, koaro, in the Piako catchment for the first time is also an encouraging sign of dispersal/migration throughout the catchment. The relative proportion of species was fairly consistent in each stream over time; although small inter-annual variations were apparent there were no strong directional trends in assemblage composition in four of the five streams. There was, however, some indication of a directional trend in Mangapapa Stream, which is likely to be driven by the increased abundance of Cran's bullies. Comparison of size distributions between years indicated that shortfin eel population dynamics have remained consistent, although there is a lack of large eels in two (Mangakahika and Piakonui) of the five sites. Bully size distributions have not been similar between years, indicating inter-annual variability in recruitment. In fact, with three years of data it appears there may be cyclical trends in population dynamics which span multiple years. Further annual monitoring is necessary to clarify the patterns and duration of these trends.

The macroinvertebrate community scores for streams in the Piako catchment improved in three sites (Mangakahika, Mangapapa, Waitakaruru) and remained constant in one site (Piakonui). The MCI score for Waitoa Stream declined back to the 2014 level after improving from 'good' to 'excellent' in 2015. Overall, these fluctuations are consistent with observed inter-annual variability in MCI scores.

Increased periphyton coverage, after a decline in 2015, may be associated with the lower MCI score at the Waitoa Stream site. The enhanced periphyton growth is likely to be a consequence of the reduced macrophyte cover in 2015; the macrophytes were probably out-shading the algae in previous years. Further monitoring of concurrent macrophyte and periphyton cover changes in subsequent years will be required to confirm this hypothesis. Habitat scores remained within the range of past fluctuations, and changes in score were most frequently associated with changes in bank stability and/or sediment deposition.

4.2 Waihou catchment

In the Waihou catchment, the numbers of shortfin eels were lower at three sites (Wairere, Waiteariki, and Waitawheta) in 2016 than in 2015, they remained relatively constant at one site (Paiakarahi), and were substantially higher at one site (Karengorengo; though this may have been due to inefficient electric-fishing as a result of high macrophyte cover in past years). Common and Cran's bully abundances, on the other hand, were higher in all sites in 2016 than in 2015. Redfin bullies were captured for the first time, in Waitawheta Stream. The redfin bullies at this site ranged from 40 to 76 mm in length, with the overall mix of fish sizes likely indicative of two cohorts being present. Given that there are relatively few records of redfin bullies in the Waihou catchment, and that they have not been recorded in the previous two surveys at this site, the appearance of redfin bullies at this site is of interest. Gambusia were also captured for the first time in the Waihou catchment in Karengorengo Stream. Banded kokopu were only found in one of the three sites in which they have been previously observed, and inanga in one of two previous locations. However, distributions of these species are often patchy, and it is likely that they are just rare in these reaches, rather than absent. This conjecture is supported by the fact that banded kokopu were found in 2016 in a site in which they were not captured in 2015, and inanga were found in Karengorengo stream in 2015, despite being absent from that site in 2014. Community composition remained similar between years in most sites, although there were indications of possible directional trends in assemblage composition in Karengorengo and Waitawheta Streams. Like in the Piako streams, the size distributions of eels were similar between years, while bully populations were more variable, perhaps reflecting inter-annual cycles in recruitment.

Macroinvertebrate taxa richness was lower in four of the five sites in 2016 compared to 2015. However, the 2015 counts were the highest to date, and this year's values are similar to those observed in 2014. Interestingly, MCI scores still improved in all sites despite the declines in taxa richness, EPT richness, and percent EPT abundance. Consequently, all but one of the sites (Karengorengo) were in the 'excellent' class. Karengorengo improved from 'fair' to 'good,' possibly in association with reduced macrophyte cover. MCI scores were correlated with habitat scores, which also improved in all five Waihou sites between 2015 and 2016.

In both catchments, few juvenile longfin eels were captured, indicating that the recruitment of longfin eels may currently be relatively poor. For shortfin eels, on the other hand, there were very few large female fish captured, perhaps indicating poor growth/survival rates for this species, high fishing pressure, or a lack of suitable habitat.

The 2016 survey results indicate that higher summer flows appear to improve connectivity within these catchments. Several new species were found in sites where they had not previously been present in the past several years, including inanga, koaro, and redfin bullies (as well as the exotic species *Gambusia*). There was also an increase in torrentfish abundance in multiple sites, which may also be linked to higher rainfall and thus higher base flows in 2016. Determining the levels of flow

which support dispersal and migration in these catchments is of extreme relevance to any future water allocation plans, but also a challenging task.

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.

Knowledge of natural dynamics and variability in New Zealand's freshwater ecological communities is relatively limited, particularly for fish. Conducting long-term routine ecological monitoring allows the identification of instream values and characterisation of trends and differences in community population dynamics over time and between sites. This provides the knowledge that can be used to support development of robust and transparent management policies.

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 samplings highlight 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. In addition, the preliminary indication of associations between flow levels and the occurrence of rarer species in some of the sites, possibly linked to enhanced connectivity, suggests that it will be important to determine minimum flows for safeguarding native fish populations. 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 continuous flow monitoring gauges at each of the sample sites, or at the very least establish correlative relationships with existing nearby gauging stations, to help relate observed changes in ecological communities with flow. 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 annual monitoring sites, it may be valuable to monitor a further group of sites at less frequent intervals (i.e., every 3-5 years) to improve the spatial coverage of the monitoring. Some sites may already be included in the standard WRC REMS monitoring programme and it may be beneficial to include reference to these data as they are collected. It may also be useful to collect additional data on water quality at the annual monitoring sites, including continuous measurements of water temperature and dissolved oxygen via in-stream loggers to better understand the relative importance of different environmental variables in determining the observed variations in ecology.

The establishment of this ecological monitoring programme in the Waihou and Piako catchments is a first step to understanding the ecological communities and dynamics that exist and therefore in setting appropriate protection levels. Evidence from these surveys already demonstrates the differences in structure and functioning of the ecological communities at different sites and particularly a difference is emerging between more and less heavily modified sites e.g., Piakonui versus Waitoa in the Piako catchment, and Paiakarahi versus Karengorengo in the Waihou catchment. 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 flow gauges at each site to collect continuous flow data would be helpful for establishing relationships between ecological response variables and flow. There are indications that flow may influence the occurrence of rarer fish species within these catchments; understanding this relationship is critical for informing future water allocations decisions.
- It would be beneficial for additional physico-chemical variables to also be collected at each of the sites, e.g., water temperature and water quality. This would allow evaluation of the relative importance of different environmental variables in determining the observed variations in ecology. Where possible, this should include regular sampling (preferably continuous), rather than one-off spot samples.
- To improve the spatial coverage of the monitoring, it may be valuable to introduce a further group of sites for monitoring once every 3-5 years. It is likely possible that suitable sites already exist as part of the WRC REMS network.
- It would be beneficial to collate historical ecological monitoring data (e.g., REMS) collected by WRC in the catchments to supplement the analyses undertaken as part of this programme.

7 Acknowledgements

The assistance of Mike Martin and Siobhan Culhane in completing the fieldwork was greatly appreciated.

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Appendix A Habitat assessment forms

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

Stream name: Mangakahika Stream		Assessor: Mike Martin	
Site number: 376-4	Sample number: 1	Date: 02/03/2016	Time: 09:15
GPS coordinates	Downstream:	E 1818698	N 5838814
	Upstream:	E 1818618	N 5838767

Channel & riparian features

Canopy cover:

Open	**Partly shaded**	Very shaded

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 4.6m
Stream width (water): 2.85m
Stream depth: 0.13m
Surface velocity:

Water quality

Temperature:	18.1	°C	Conductivity:	127.6	µS cm^{-1}
Dissolved oxygen:	81	%	7.66	mg l^{-1}	

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

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

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

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Habitat types sampled

(% of effort)

Stones:	80%		
Wood:	20%	Riffles:	50 %
Macrophyte:	%	Runs:	50%
Edges:	%		

Number of invertebrates returned:

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Mangakahika		Site number: 374-4
Sample number: 1	Assessor: Mike Martin	Date: 02/03/2016

Habitat parameter	Category: Optimal	Suboptimal	Marginal	Poor
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense	• Bankside vegetation buffer is <10m • Mostly continuous	• Pathways present and/or stock • Mostly healed over	• Breaks frequent • Human activity obvious
Left bank:9	20 19 18 17 16	15 14 13 12 11	10 **9** 8 7 6	5 4 3 2 1
Right bank:12	20 19 18 17 16	15 14 13 **12** 11	10 9 8 7 6	5 4 3 2 1
Mean: 10.5				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry	• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common	• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank
Left bank: 8	20 19 18 17 16	15 14 13 12 11	10 9 **8** 7 6	5 4 3 2 1
Right bank:10	20 19 18 17 16	15 14 13 12 11	**10** 9 8 7 6	5 4 3 2 1
Mean: 9				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected	• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded	• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods	• Unstable • Many eroded areas • 60-100% of bank has erosional scars
Left bank:10	20 19 18 17 16	15 14 13 12 11	**10** 9 8 7 6	5 4 3 2 1
Right bank:13	20 19 18 17 16	15 14 **13** 12 11	10 9 8 7 6	5 4 3 2 1
Mean: 11.5				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key	• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15	• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25	• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25
Score: 18	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern	• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present	• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted	• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent
Score:17	20 19 18 **17** 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat parameter	Category Optimal	Habitat parameter	Category Optimal	Habitat parameter
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition	• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools	• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends	• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition
Score: 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	• 3 0f 4 velocity/depth regimes present • If fast/shallow is missing then score lower	• 2 of 4 velocity/depth regimes present • If fast/shallow or slow/shallow are missing, score low	• Dominated by 1 velocity/depth regime • Usually deep/slow
Score: 18	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient	• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment	• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes
Score:15	20 19 18 17 16	**15** 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not evident on hand held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch	• Periphyton visible • <20% cover of available substrates	• Periphyton obvious & prolific • >20% cover of available substrates
Score: 12	20 19 18 17 16	15 14 13 **12** 11	10 9 8 7 6	5 4 3 2 1
TOTAL SCORE: 122				

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

Stream name: Waitoa Stream U/S		Assessor: Josh Smith	
Site number: 1249-121	Sample number: 2	Date: 02/03/2016	Time: 16:40
GPS coordinates	Downstream:	E1831974	N5803819
	Upstream:	E1831878	N5803808

Channel & riparian features

Canopy cover:

Open	Partly shaded	Very shaded

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 7m
Stream width (water): 1.6m
Stream depth: 0.2m
Surface velocity: 0.3m s^{-1}

Water quality

Temperature:	21	°C	Conductivity:	-	µS cm^{-1}
Dissolved oxygen:	97.8	%	8.65	mg l^{-1}	
Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	5
Cobble	>64-256mm	70
Gravel	>2-64mm	5
Sand	>0.06-2mm	5
Silt	0.004-0.06mm	5
Clay	<0.004mm	10

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Habitat types sampled

(% of effort)

Stones:	45%		
Wood:	%	Riffles:	20%
Macrophyte:	20%	Runs:	75%
Edges:	35%	Pools:	5%

Number of invertebrates returned:

Koura: Y	Shrimps: Y(1only)
Crabs: N	Mussels: N
Other:	
Mussel type:	
Hyridella	*Cucumerunio*

Comments:

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																				
Stream name: Waitoa Stream U/S						Site number: 1249-121														
Sample number: 2						Assessor: Josh Smith										Date: 02/03/2016				
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
Left bank: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 surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
Left bank: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																				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
Left bank: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																				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
Score: 15	20	19	18	17	16	**15**	14	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
Score:16	20	19	18	17	**16**	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat parameter	Category Optimal	Habitat parameter	Category Optimal	Habitat parameter
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition	• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools	• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends	• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition
Score: 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	• 3 0f 4 velocity/depth regimes present • If fast/shallow is missing then score lower	• 2 of 4 velocity/depth regimes present • If fast/shallow or slow/shallow are missing, score low	• Dominated by 1 velocity/depth regime • Usually deep/slow
Score: 13	20 19 18 17 16	15 14 **13** 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient	• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment	• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes
Score: 15	20 19 18 17 16	**15** 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not evident on hand held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch	• Periphyton visible • <20% cover of available substrates	• Periphyton obvious & prolific • >20% cover of available substrates
Score: 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	**5** 4 3 2 1
TOTAL SCORE: 94				

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

Stream name: Mangapapa Stream		Assessor: Josh Smith	
Site number: 433-14	Sample number: 3	Date: 03/03/2016	Time: 14:00
GPS coordinates	Downstream:	E 1836783	N 5809932
	Upstream:	E 1836750	N 5809802

Channel & riparian features

Canopy cover:

Open	Partly shaded	Very shaded

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 6.5m
Stream width (water): 4m
Stream depth: 0.15m
Surface velocity: 0.2m s^{-1}

Water quality

Temperature:	20.1	°C	Conductivity:	NA	µS cm^{-1}
Dissolved oxygen:	107.8	%	9.73	mg l^{-1}	

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

Stream-bottom substrata

Compaction (inorganic substrata): -SEE BEDROCK

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	95
Boulder	>256mm	
Cobble	>64-256mm	
Gravel	>2-64mm	
Sand	>0.06-2mm	3
Silt	0.004-0.06mm	2
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Habitat types sampled

(% of effort)

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

Number of invertebrates returned:

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

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Mangapapa Stream	Site number: 433-14	
Sample number: 6	Assessor: Joshua Smith	Date: 03/03/2016

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

Habitat parameter	Category Optimal					Habitat parameter					Category Optimal					Habitat parameter				
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition					• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools					• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends					• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition				
Score: 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 velocity/depth regimes present • Slow/deep, slow/shallow, fast/shallow, fast/deep					• 3 0f 4 velocity/depth regimes present • If fast/shallow is missing then score lower					• 2 of 4 velocity/depth regimes present • If fast/shallow or slow/shallow are missing, score low					• Dominated by 1 velocity/depth regime • Usually deep/slow				
Score: 13	20	19	18	17	16	15	14	**13**	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient					• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material					• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment					• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes				
Score: 10	20	19	18	17	16	15	14	13	12	11	**10**	9	8	7	6	5	4	3	2	1
9. Periphyton	• Periphyton not evident on hand held stones • Stable substrate • Surfaces rough to touch					• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch					• Periphyton visible • <20% cover of available substrates					• Periphyton obvious & prolific • >20% cover of available substrates				
Score: 7	20	19	18	17	16	15	14	13	12	11	10	9	8	**7**	6	5	4	3	2	1
TOTAL SCORE: 97																				

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

Stream name: Waitakaruru Stream		Assessor: Mike Martin	
Site number: 1231-54	Sample number: 4	Date: 04/03/2016	Time: 10:15
GPS coordinates	Downstream:	E 1817745	N 5815748
	Upstream:	E 1817903	N 5815670

Channel & riparian features

Canopy cover:

Open | **Partly shaded** | Very shaded

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel):3m
Stream width (water): 2m
Stream depth: 0.3m
Surface velocity: 0.2m s^{-1}

Water quality

Temperature:	18.2	°C	Conductivity:	138.1	µS cm^{-1}
Dissolved oxygen:	89.7	%	8.43	mg l^{-1}	

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

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

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

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Habitat types sampled

(% of effort)

Stones:	50%		
Wood:	25%	Riffles:	45%
Macrophyte:	25%	Runs:	50%
Edges:	%	Pools:	5%

Number of invertebrates returned:

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Waitakaruru Stream		Site number: 1231-54
Sample number: 4	Assessor: Mike Martin	Date: 04/03/2016

Habitat parameter	Category: Optimal	Suboptimal	Marginal	Poor
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense	• Bankside vegetation buffer is <10m • Mostly continuous	• Pathways present and/or stock • Mostly healed over	• Breaks frequent • Human activity obvious
Left bank:9	20 19 18 17 16	15 14 13 12 11	10 **9** 8 7 6	5 4 3 2 1
Right bank:10	20 19 18 17 16	15 14 13 12 11	**10** 9 8 7 6	5 4 3 2 1
Mean: 9.5				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry	• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common	• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank
Left bank:8	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: 8.5				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected	• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded	• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods	• Unstable • Many eroded areas • 60-100% of bank has erosional scars
Left bank:13	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: 14				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key	• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15	• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25	• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25
Score: 11	20 19 18 17 16	15 14 13 12 **11**	10 9 8 7 6	5 4 3 2 1
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern	• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present	• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach Channelized & disrupted	• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent
Score: 16	20 19 **18** 17 **16**	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

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

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

Stream name: Piakonui Stream		Assessor: Josh Smith	
Site number: 765-15	Sample number: 5	Date: 03/03/2016	Time: 17:30
GPS coordinates	Downstream:	E 1831211	N 5815768
	Upstream:	E 1831210	N 5809980

Channel & riparian features

Canopy cover:

Open | Partly shaded | **Very shaded**

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 3.5m
Stream width (water): 2.6m
Stream depth: 0.15m
Surface velocity: 0.20m s^{-1}

Water quality

Temperature:	16.4	°C	Conductivity:	NA	µS cm^{-1}
Dissolved oxygen:	95.1	%	9.3	mg l^{-1}	

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

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	40
Cobble	>64-256mm	25
Gravel	>2-64mm	10
Sand	>0.06-2mm	5
Silt	0.004-0.06mm	20
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Habitat types sampled

(% of effort)

Stones:	50%		
Wood:	%	Riffles:	20%
Macrophyte:	%	Runs:	70%
Edges:	50%	Pools:	10%

Number of invertebrates returned:

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

Comments:

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																					
Stream name: Piakonui Stream										Site number: 5											
Sample number: 753-15						Assessor: Josh Smith										Date: 03/03/2016					
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor					
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious					
Left bank:19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
Right bank:17	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
Mean: 18																					
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank					
Left bank:19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
Right bank:17	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
Mean: 18																					
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars					
Left bank: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																					
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25					
Score: 16	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach Channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent					
Score: 17	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	

Habitat parameter	Category					Habitat parameter					Category					Habitat parameter				
	Optimal										Optimal									
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition					• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools					• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends					• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition				
Score: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Velocity/depth regimes	• 4 velocity/depth regimes present • Slow/deep, slow/shallow, fast/shallow, fast/deep					• 3 0f 4 velocity/depth regimes present • If fast/shallow is missing then score lower					• 2 of 4 velocity/depth regimes present • If fast/shallow or slow/shallow are missing, score low					• Dominated by 1 velocity/depth regime • Usually deep/slow				
Score: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient					• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material					• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment					• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes				
Score: 17	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	• Periphyton not evident on hand held substrates (macrophytes, wood etc.,) or fine sediments					• Periphyton not visible on substrates but obvious to touch					• Periphyton visible • <20% cover of available substrates					• Periphyton obvious & prolific • >20% cover of available substrates				
Score: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 153																				

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

Stream name: Paiakarahi Stream D/S		Assessor: Kathryn Reeve	
Site number: 718-5	Sample number: 6	Date: 03/03/2016	Time: 16:05
GPS coordinates	Downstream:	E1841027	N5867879
	Upstream:	E1841098	N5867799

Channel & riparian features

Canopy cover:

Open	**Partly shaded**	Very shaded

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 7.2m
Stream width (water): 3.9m
Stream depth: 0.44m
Surface velocity:

Water quality

Temperature:	17.5	°C	Conductivity:	73	µS cm^{-1}
Dissolved oxygen:	85.8	%	8.13		mg l^{-1}

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

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	50
Cobble	>64-256mm	30
Gravel	>2-64mm	20
Sand	>0.06-2mm	
Silt	0.004-0.06mm	
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Habitat types sampled

(% of effort)

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

Number of invertebrates returned:

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

Comments:

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																				
Stream name: Paiakarahi Stream D/S								Site number: 718-5												
Sample number: 6						Assessor: Kathryn Reeves								Date: 03/03/16						
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
Left bank:20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 20																				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
Left bank: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																				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
Left bank:14	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:12	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 13																				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
Score: 18	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach Channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
Score: 20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat parameter	Category					Habitat parameter					Category					Habitat parameter				
	Optimal										Optimal									
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition					• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools					• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends					• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition				
Score: 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 velocity/depth regimes present • Slow/deep, slow/shallow, fast/shallow, fast/deep					• 3 0f 4 velocity/depth regimes present • If fast/shallow is missing then score lower					• 2 of 4 velocity/depth regimes present • If fast/shallow or slow/shallow are missing, score low					• Dominated by 1 velocity/depth regime • Usually deep/slow				
Score: 14	20	19	18	17	16	15	**14**	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient					• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material					• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment					• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes				
Score: 19	20	**19**	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	• Periphyton not evident on hand held substrates (macrophytes, wood etc.,) or fine sediments					• Periphyton not visible on substrates but obvious to touch					• Periphyton visible • <20% cover of available substrates					• Periphyton obvious & prolific • >20% cover of available substrates				
Score: 18	20	19	**18**	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE:157																				

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

Stream name: Karengorengo Stream		Assessor: Mike Martin	
Site number: 232-3	Sample number: 7	Date: 02/03/2016	Time: 14:30
GPS coordinates	Downstream:	E 1848393	N 5823235
	Upstream:	E 1848423	N 5823069

Channel & riparian features

Canopy cover:

Open	Partly shaded	Very shaded

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 3.8m
Stream width (water): 2.3m
Stream depth: 0.37m
Surface velocity: m s^{-1}

Water quality

Temperature:	19.8	°C	Conductivity:	149.8	µS cm^{-1}
Dissolved oxygen:	58.5	%	5.33		mg l^{-1}

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

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	
Cobble	>64-256mm	
Gravel	>2-64mm	40
Sand	>0.06-2mm	40
Silt	0.004-0.06mm	20
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Habitat types sampled

(% of effort)

Stones:	%		
Wood:	10%	Riffles:	%
Macrophyte:	%	Runs:	100%
Edges:	%		

Number of invertebrates returned:

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Wadeable Soft-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																					
Stream name: Karengorengo Stream						Site number: 232-3															
Sample number: 7						Assessor: Mike Martin										Date: 02/03/2016					
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor					
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious					
Left bank:3	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: 3																					
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank					
Left bank:8	20	19	18	17	16	15	14	13	12	11	10	9	**8**	7	6	5	4	3	2	1	
Right bank:8	20	19	18	17	16	15	14	13	12	11	10	9	**8**	7	6	5	4	3	2	1	
Mean:8																					
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars					
Left bank:6	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: 7.5																					
4. Channel sinuosity	• Bends increase stream length 3-4 times longer than if it was straight					• Bends increase stream length 2-3 times longer than if it was straight					• Bends increase stream length 1-2 times longer than if it was straight					• Channel straight					
Score: 8	20	19	18	17	16	15	14	13	12	11	10	9	**8**	7	6	5	4	3	2	1	
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent					
Score:13	20	19	18	17	16	15	14	**13**	12	11	10	9	8	7	6	5	4	3	2	1	

Habitat parameter	Category Optimal	Habitat parameter	Category Optimal	Habitat parameter
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition	• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools	• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends	• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition
Score:8	20 19 18 17 16	15 14 13 12 11	10 9 **8** 7 6	5 4 3 2 1
7. Pool variability	• Pools evenly mixed • Large/shallow, large/deep, small/shallow, small/deep	• Majority of pools large/deep • Very few shallow pools	• Prevalence of shallow pools	• Majority of pools small/shallow
Score: 13	20 19 18 17 16	15 14 **13** 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient	• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment	• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes
Score: 8	20 19 18 17 16	15 14 13 12 11	10 9 **8** 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not evident on hand held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch	• Periphyton visible • <20% cover of available substrates	• Periphyton obvious & prolific • >20% cover of available substrates
Score: 18	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
TOTAL SCORE: 86.5				

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

Stream name: Wairere Stream		Assessor: Josh Smith	
Site number: 1224-5	Sample number: 8	Date: 02/03/2016	Time: 12:00
GPS coordinates	Downstream:	E 2742184	N 6365455
	Upstream:	E 2742094	N 6365394

Channel & riparian features

Canopy cover:

Open | **Partly shaded** | Very shaded

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 8.5m
Stream width (water): 6m
Stream depth: 0.4m
Surface velocity: 0.5m s^{-1}

Water quality

Temperature:	16.3	°C	Conductivity:	NA	µS cm^{-1}
Dissolved oxygen:	98.5	%	9.72	mg l^{-1}	
Turbidity:	**Clear**	Slightly turbid	Highly turbid	Stained	Other

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	5
Cobble	>64-256mm	65
Gravel	>2-64mm	20
Sand	>0.06-2mm	10
Silt	0.004-0.06mm	
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Habitat types sampled

(% of effort)

Stones:	50%		
Wood:	%	Riffles:	10%
Macrophyte:	%	Runs:	80%
Edges:	50%	Pools:	10%

Number of invertebrates returned:

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

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																				
Stream name: Wairere stream							Site number: 1224-5													
Sample number: 8						Assessor: Josh Smith									Date: 02/03/2016					
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
Left bank:18	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: 15.5																				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
Left bank: 18	20	19	**18**	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:9	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	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
Left bank:18	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: 15.5																				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
Score: 14	20	19	18	17	16	15	**14**	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
Score:17	20	19	18	**17**	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat parameter	Category Optimal					Habitat parameter					Category Optimal					Habitat parameter				
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition					• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools					• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends					• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition				
Score: 18	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Velocity/depth regimes	• 4 velocity/depth regimes present • Slow/deep, slow/shallow, fast/shallow, fast/deep					• 3 0f 4 velocity/depth regimes present • If fast/shallow is missing then score lower					• 2 of 4 velocity/depth regimes present • If fast/shallow or slow/shallow are missing, score low					• Dominated by 1 velocity/depth regime • Usually deep/slow				
Score: 18	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient					• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material					• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment					• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes				
Score: 18	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	• Periphyton not evident on hand held stones • Stable substrate • Surfaces rough to touch					• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch					• Periphyton visible • <20% cover of available substrates					• Periphyton obvious & prolific • >20% cover of available substrates				
Score: 5	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE 134.5																				

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

Stream name: Waiteariki stream		Assessor: Josh Smith	
Site number: 1430-10	Sample number: 9	Date: 04/03/2016	Time: 16:00
GPS coordinates	Downstream:	E 1852566	N 5818150
	Upstream:	E 1852697	N 5818212

Channel & riparian features

Canopy cover:

Open	**Partly shaded**	Very shaded

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 9.5m
Stream width (water): 8m
Stream depth: 0.55m
Surface velocity: 0.8m s^{-1}

Water quality

Temperature:	16.2	°C	Conductivity:	NA	µS cm^{-1}
Dissolved oxygen:	98.7	%	9.7	mg l^{-1}	

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

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	40
Cobble	>64-256mm	50
Gravel	>2-64mm	5
Sand	>0.06-2mm	5
Silt	0.004-0.06mm	
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Habitat types sampled

(% of effort)

Stones:	50%		
Wood:	%	Riffles:	50%
Macrophyte:	%	Runs:	40%
Edges:	50%	Pools:	5%

Number of invertebrates returned:

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

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Waiteariki Stream	Site number: 9	
Sample number: 1430-10	Assessor: Josh Smith	Date: 04/03/2016

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

Habitat parameter	Category					Habitat parameter					Category					Habitat parameter				
	Optimal										Optimal									
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition					• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools					• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends					• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition				
Score: 18	20	19	**18**	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Velocity/depth regimes	• 4 velocity/depth regimes present • Slow/deep, slow/shallow, fast/shallow, fast/deep					• 3 0f 4 velocity/depth regimes present • If fast/shallow is missing then score lower					• 2 of 4 velocity/depth regimes present • If fast/shallow or slow/shallow are missing, score low					• Dominated by 1 velocity/depth regime • Usually deep/slow				
Score: 19	20	**19**	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient					• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material					• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment					• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes				
Score: 18	20	19	**18**	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	• Periphyton not evident on hand held substrates (macrophytes, wood etc.,) or fine sediments					• Periphyton not visible on substrates but obvious to touch					• Periphyton visible • <20% cover of available substrates					• Periphyton obvious & prolific • >20% cover of available substrates				
Score: 10	20	19	18	17	16	15	14	13	12	11	**10**	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 145.5																				

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

Stream name: Waitawheta River		Assessor: Mike Martin	
Site number: 1235-11	Sample number: 10	Date: 3/3/2016	Time: 12:30
GPS coordinates	Downstream:	E 1845480	N 5849622
	Upstream:	E 1845388	N 5849622

Channel & riparian features

Canopy cover:

Open | **Partly shaded** | Very shaded

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

Instream hydraulic conditions

Estimated or measured reach average:

Stream width (active channel): 4.9m
Stream width (water): 4.2m
Stream depth: 0.13m
Surface velocity:

Water quality

Temperature:	14.4	°C	Conductivity:	159	µS cm^{-1}
Dissolved oxygen:	89.2	%	9.01		mg l^{-1}

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

Stream-bottom substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping
Moderately packed with some overlapping
Mostly a loose assortment with little overlap
No packing/loose assortment easily moved

Embeddedness:

(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	30
Cobble	>64-256mm	60
Gravel	>2-64mm	10
Sand	>0.06-2mm	
Silt	0.004-0.06mm	
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Habitat types sampled

(% of effort)

Stones:	90%		
Wood:	10%	Riffles:	40%
Macrophyte:	%	Runs:	60%
Edges:	%		

Number of invertebrates returned:

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

Comments:

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																				
Stream name: Waitawheta River							Site number: 1235-11													
Sample number: 10						Assessor: Mike Martin									Date: 3/03/2016					
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
Left bank:13	20	19	18	17	16	15	14	**13**	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:14	20	19	18	17	16	15	**14**	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 13.5																				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
Left bank: 13	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: 12																				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
Left bank:11	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: 12.5																				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
Score: 18	20	19	**18**	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern					• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present					• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach channelized & disrupted					• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent				
Score:18	20	19	**18**	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat parameter	Category Optimal					Habitat parameter					Category Optimal					Habitat parameter				
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition					• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools					• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends					• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition				
Score: 19	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
7. Velocity/depth regimes	• 4 velocity/depth regimes present • Slow/deep, slow/shallow, fast/shallow, fast/deep					• 3 0f 4 velocity/depth regimes present • If fast/shallow is missing then score lower					• 2 of 4 velocity/depth regimes present • If fast/shallow or slow/shallow are missing, score low					• Dominated by 1 velocity/depth regime • Usually deep/slow				
Score: 13	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient					• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material					• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment					• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes				
Score:14	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	• Periphyton not evident on hand held stones • Stable substrate • Surfaces rough to touch					• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch					• Periphyton visible • <20% cover of available substrates					• Periphyton obvious & prolific • >20% cover of available substrates				
Score: 15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 135																				

Appendix B Fish surveys

Fish collection form – Wadeable streams/rivers

Team members: Kathryn Reeves (NIWA) Mike Martin (NIWA) Siobhan Culhane (NIWA)	GPS (d/s): E1818698 N5838814 GPS (u/s): E1818618 N5838767	Site: Mangakahika Stream				Date: 02/03/2016
		Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: M.M.	Total shock time (min): 54	Fishing time: Start 10:45 Finish 12:30	Sample distance (m): 150	Wetted width (m):	A		C		E		G		I	
					B	2.2	D	1.1	F	2.85	H	1.15	J	3.15

Sampling gear:	Spotlight	EFM	Seine	Length (m) / Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C):	18.1	Conductivity (µS):	127.6								
EFM anode:	Big / Small	EFM volts (x100): 3	EFM pulse rate (Hz or pps): 60	EFM pulse width (ms): 2	Spotlight (watts):															

Species	Sub-reach tally										Total count	Sample count	Length (mm)		FLAG
	A	B	C	D	E	F	G	H	I	J			Min.	Max.	
Common bully	11	6	11	15	4		17	15	9	8	96		20	72	
Banded kokopu	1		1	1	1	1	1	2	1	2	11		53	205	
Shortfin eel	3	2	4	1	4	4	2	3	2	5	30		103	450	
Longfin eel	1		1	1	2	1	1			1	8		179	950	
Koura		1	2	2			1				6				
Total	16	9	19	20	11	6	23	20	12	16	152				

FLAG	Comment	FLAG	Comment
	Missed 17 common bullies 30 – 55mm (Have been included within counts)		
	Missed 7 shortfin eels (Have been included within counts)		
	Missed 1 banded kokopu (included in count)		

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Glenys Croker (NIWA), Elizabeth Graham (NIWA), Samira van Hunen (NIWA)	GPS (d/s): E 1831914 N 5803819 GPS (u/s): E 1831878 N 5803808	Site: Waitoa 1249-121	Date: 2/3/2016			
		Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: Y	Total shock time (min): 109	Fishing time: Start 16:40 Finish 20:10	Sample distance (m): 150	Wetted width (m):	A	1.6	C	1.4	E	1.4	G	1.9	I	1.2
					B	1.4	D	1.5	F	1.9	H	2.5	J	1.7

Sampling gear:	Spotlight	EFM	Seine	Length (m) / Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C): 21		Conductivity (µS): NA	

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

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Cran's bully	27	4	19	13	11	31	45	39	72	60	321		19	85	
Shortfin eel	11	10	11	10	7	8	15	17	21	24	134		81	1000	
Longfin eel				1			1		1	1	4		330	760	
Elver				1		3	1	2		2	9				
Paratya				1							1				
Koura	4	2	6	2	1	3	9	9	3	11	50				
Total	42	16	36	28	19	45	71	67	97	98	519				

FLAG	Comment	FLAG	Comment
	Stream higher than normal – but clear		Missed 21 shortfin eels (90 – 260mm) – included in count
			Missed 9 elvers - (no sizes estimated but included within count)
			Missed 76 Cran's bullies (no sizes estimated but included within count)

Fish collection form – Wadeable streams/rivers

Team members: Glenys Croker (NIWA) Josh Smith (NIWA) Kerry Costley (NIWA)	GPS (d/s): E 1836783 N 5809932 GPS (u/s): E 1836750 N 5809802	Site: Mangapapa Stream 433-14				Date: 3/3/2016
		Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id:	Total shock time (min): 83	Fishing time:	Start 10:30 Finish 14:00	Sample distance (m): 150	Wetted width (m):	A	4.9	C	4	E	2.7	G	3	I	4.4
						B	6.3	D	3.8	F	3.4	H	5.1	J	

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C): 20.1		Conductivity (µS): NA		
EFM anode:	Big Small	EFM volts (x100): 3		EFM pulse rate (Hz or pps): 60		EFM pulse width (ms): 2			Spotlight (watts):				

Species	Sub-reach tally										Total count	Sample count	Length (mm)		FLAG
	A	B	C	D	E	F	G	H	I	J			Min.	Max.	
Cran's bully	21	16	51	26	22	24	27	11	19	5	222		19	62	
Shortfin eel	6	6	15	8	8	9	7	8		3	70		86	590	
Longfin eel	2	3	3	1		1	1	1	1		13		92	520	
Inanga				1	1						2		66	85	
Koura	3	1	5	4	1	1	7	6	1	5	34				
Elver							1				1				
Total	32	26	74	40	32	35	43	26	21	13	342				

FLAG	Comment	FLAG	Comment
	Water level higher than normal but clear		Missed 25 bullies (no sizes estimated but included within count)
			Missed 6 shortfin 100-120mm – included in count

Fish collection form – Wadeable streams/rivers

Team members: Mike Martin (NIWA) Kathryn Reeve (NIWA) Siobhan Culhane (NIWA)	GPS (d/s): E 1817745 N 5815748 GPS (u/s): E 1817903 N 5815670	Site: Waitakaruru Stream 1231-54				Date: 04/03/2016
		Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: SC	Total shock time (min): 78	Fishing time: Start 10:15 Finish 14:15	Sample distance (m): 150	Wetted width (m):	A		C		E		G		I			
					B	1.8	D	1.9	F	2.1	H	2.2	J	1.85		

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C): 18.2	Conductivity (µS): 138.1

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

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Cran's bully	9	11	9	10	9	2	5	3	11	5	74		23	55	
Shortfin eel	9	4	1	5	8	5	7	5	12	10	66		105	740	
Koura	3	7	8	2	1	6	13	4	7	3	54				
Total	21	22	18	17	18	13	25	12	30	18	194				

FLAG	Comment	FLAG	Comment
	From section G – H, choked up with pond weed and some Lm		Missed 13 shortfin eels 150-350mm – included in count
			Missed 6 crans bullies 30-50mm – included in count

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA) Glenys Croker (NIWA) Kerry Costley (NIWA)	GPS (d/s): E 1831211 N 5815768 GPS (u/s): E 1831210 N 5809980	Site: Piakonui Stream 753-15	Date: 3/3/2016			
		Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id:	Total shock time (min): 50	Fishing time:	Start 15:30 Finish 17:22	Sample distance (m): 150	Wetted width (m):	A	3.22	C	3.3	E	2.1	G	1.9	I	2.9
						B	3.6	D	2.2	F	2.4	H	1.8	J	5.5

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C): 16.4									Conductivity (µS): NA	

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

Species	Sub-reach tally										Total count	Sample count	Length (mm)		FLAG
	A	B	C	D	E	F	G	H	I	J			Min.	Max.	
Common bully		1		1			2	1	4	25	34		24	70	
Banded kokopu		3		2					2		7		90	178	
Shortfin eel	4	2	3		2	2	1	1	1	1	17		94	240	
Elver			1			1				1	3				
Koaro			1								1		80	80	
Koura	24	14	19	17	27	17	19	31	11	28	207				
Total	28	20	24	20	29	20	22	33	18	55	269				

FLAG	Comment	FLAG	Comment
	Koura abundant in all reaches		Missed 3 elvers (included in count)
	Josh fishing		
	Section J - large pool - lots of sediment& lots of bullies here.		
	stream higher than normal but clear		

Fish collection form – Wadeable streams/rivers

Team members: Kathryn Reeve (NIWA) Mike Martin (NIWA) Siobhan Culhane (NIWA)	GPS (d/s): E 1841027 N 5867879 GPS (u/s): E 1841098 N 5867799	Site: Paiakarahi Stream D/S 718-5	Date: 3/3/2016		
Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id: K.R.	Total shock time (min): 51	Fishing time: Start 16:00 Finish 19:15	Sample distance (m): 150	Wetted width (m):	A		C		E		G		I	
					B	3.7	D	4.2	F	3.1	H	3	J	5.3

Sampling gear:	Spotlight	EFM	Seine	Length (m) / Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C):	17.6	Conductivity (µS):	73			
EFM anode: Big / Small	EFM volts (x100): 4	EFM pulse rate (Hz or pps): 60	EFM pulse width (ms): 2	Spotlight (watts):											

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Shortfin eel	1		1					1	4	1	8		92	250	I
Cran's bully	9	13	5	4	6	7	3	4	8	2	61		25	74	O
Torrentfish							1			2	3		64	145	
Brown trout					1						1		124	124	
Koura			1	1		1			1	1	5				
Total	10	13	6	4	7	7	4	5	12	6	72				

FLAG	Comment	FLAG	Comment
I	Large deep pool – too deep to fish (5m), erosion of banks TR		Missed 5 Cran's Bullies 30-60mm (included in count)
O	Some water pepper present (x4 small plants , not included in macrophyte transect		
	Water level higher and swifter than previous year		
	Section H, I, J large amount of undercutting on TR bank		

Fish collection form – Wadeable streams/rivers

Team members: Kathryn Reeve (NIWA) Mike Martin (NIWA) Siobhan Culhane (NIWA)	GPS (d/s): E 1848393 N 5823235 GPS (u/s): E 1848423 N 5823069	Site: Karengorengo Stream 232-3				Date: 2/3/2016
		Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id:	Yes	Total shock time (min):	58	Fishing time:	Start 14:00 Finish 17:38	Sample distance (m):	150	Wetted width (m):	A		C		E		G		I	
									B	2.5	D	2.3	F	1.8	H	2.4	J	2.6

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C):	19.8	Conductivity (µS):	149.8		
EFM anode:	Big Small	EFM volts (x100):	3	EFM pulse rate (Hz or pps):	60	EFM pulse width (ms):	2	Spotlight (watts):						

Species	Sub-reach tally										Total count	Sample count	Length (mm)		FLAG
	A	B	C	D	E	F	G	H	I	J			Min.	Max.	
Common bully		4	3	4	4	1	1	1	4	3	25		47	93	
Shortfin eel	36	40	32	45	40	32	40	29	36	30	360		76	700	
Inanga										1	1		80	80	
Smelt										13	13		72	95	
Gambusia					1						1		40	40	
Longfin		1									1		350	350	
Koura	12	5	19	13	14	1	1	5	5		75				
Total	48	50	54	62	59	34	42	35	45	47	476				

FLAG	Comment	FLAG	Comment
	Stopped fishing at 27m – too deep to fish. Skipped this section and moved the string up past this section		Missed 32 shortfin eels 100 – 700mm – included in count

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Glenys Croker (NIWA), Elizabeth Graham (NIWA), Samira von Hunen (NIWA)	GPS (d/s): E 1851649 N 5819801 GPS (u/s): E 1851719 N 5819721	Site: Wairere 1224-5	Date: 2/3/2016			
		Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id:	Y	Total shock time (min):	108	Fishing time:	Start 9:30 Finish 14:50	Sample distance (m):	150	Wetted width (m):	A	5.6	C		E	6.3	G	5.2	I	6.5
									B		D	6.3	F	5.7	H	6.3	J	8

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C):	16.3	Conductivity (µS):	NA								
EFM anode:	Big Small	EFM volts (x100):	3	EFM pulse rate (Hz or pps):	60	EFM pulse width (ms):	2	Spotlight (watts):												

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common bully	37			18	14	20	28	57	84	35	293		16	74	
Shortfin eel	22			7	1	5	13	28	25	19	120		22	570	
Longfin eel	1										1		1000	1000	
Elver	5			1	1	1	2			6	16				
Torrentfish								5	1	1	7		51	64	
Brown trout										1	1		106	106	
Koura	9			2	4		3	7	8	2	35				
Paratya				1		2			2	3	8				
Total	74	0	0	28	20	26	46	97	118	67	476				

FLAG	Comment	FLAG	Comment
B	Section B missed as too deep to fish		Missed 54 bullies (no sizes estimated but included within count)
C	Section C missed as too deep to fish		Missed 17 elvers (no sizes estimated but included within count)
	Stream clear – but high. 10cm above normal flow		Missed 1 shortfin eel (~400mm)

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA) Kerry Costley (NIWA) Glenys Croker (NIWA)	GPS (d/s): E 1852566 N 5818150 GPS (u/s): E 1852697 N 5818212	Site: Waiteariki 1430-10	Date: 4/3/2016

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

Fish sample id:	Yes	Total shock time (min):	90	Fishing time:	Start 10:45 Finish 15:50	Sample distance (m):	150	Wetted width (m):	A	7.6	B	7	E	16	G	6.1	I	6.3
									B		D		F		H		J	

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C):	196.2	Conductivity (µS):	NA				

EFM anode: Big / Small	EFM volts (x100): 5	EFM pulse rate (Hz or pps): 60	EFM pulse width (ms): 2	Spotlight (watts):	

Species	Sub-reach tally										Total count	Sample count	Length (mm)		FLAG
	A	B	C	D	E	F	G	H	I	J			Min.	Max.	
Shortfin eel	8	4	5	2			3	1	1	4	28		89	660	
Longfin eel				2	1	1					4		450	600	
Common Bully	30	22	23	30	10	15	10	8	5	20	173		30	90	
Banded Kokopu	4		1								5		86	190	
Torrent fish			1		2	1	2	1			7		80	125	
Koura	25	8	8	5	4	1	12	22	17	18	120				
Total	67	34	38	39	17	18	27	32	23	42	337				

FLAG	Comment	FLAG	Comment
	Stream higher than normal but clear - a lot more water to fish than normal		Missed 1 Common Bully
	Josh fishing		Missed 1 eel (unidentified) – not included in count

Fish collection form – Wadeable streams/rivers

Team members: Kathryn Reeves (NIWA) Mike Martin (NIWA) Siobhan Culhane (NIWA)	GPS (d/s): E 1845480 N 5849662 GPS (u/s): E 1845388 N 5849622	Site: Waitawheta 1235-11			Date: 03/03/2016
		Not fished	Fished none collected	Fished 10 sub-reaches	Fished 5-9 sub-reaches	Fished <5 sub-reaches	FLAG for fished/not fished

Fish sample id:	Mike M	Total shock time (min):	70	Fishing time:	Start 09:50 Finish 13:20	Sample distance (m):	150	Wetted width (m):	A		C		E		G		I	
									B	5.7	D	3.3	F	4.2	H	3.2	J	4.5

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C):	14.4	Conductivity (µS):	159		
EFM anode:	Big Small	EFM volts (x100):	3	EFM pulse rate (Hz or pps):	60	EFM pulse width (ms):	2	Spotlight (watts):						

Species	Sub-reach tally										Total count	Sample count	Length (mm)		FLAG
	A	B	C	D	E	F	G	H	I	J			Min.	Max.	
Common bully	4	8	23	22	9	6	4	5	13	2	96		30	81	
Shortfin eel	1	1	2	2		2					8		100	173	
Longfin eel	1		1					1			3		345	470	
Redfin bully	11	2	2								15		40	76	
Rainbow trout										1	1		132	132	
Koura	1	2			1	1		2	2	1	10				
Total	18	13	28	24	10	9	4	8	15	4	133				

FLAG	Comment	FLAG	Comment
	Missed 15 common bullies 35-55 mm (included within count)		

Appendix C Macrophytes and periphyton

Periphyton Assessment							
Stream: Mangakahika Stream		Date: 2/3/2016					
Sample Number: 1		Located number: 376-4					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	25	25	10	10	5	15
Medium mat/film (0.5-3mm thick)	Green (% cover)						
	Light brown (% cover)						
	Black/dark brown (% cover)						
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Submerged bryophytes	NA						
Iron Bacteria growths	NA						

Macrophyte recording sheet											
Stream: Mangakahika Stream			**Located number**: 376-4				**Sample Number**: 1			**Date**: 2/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Total submerged	Submerged plants				Emergent plants		
					Surface-reaching		Below surface				
					Sub-total	Species	Sub-total	Species	Total emergent	Species	
1	2.2	2.2	0						0		
2	1.1	1.6	0						0		
3	2.85	4.6	0						0		
4	1.15	3.05	0						0		
5	3.15	4.1	2						2	2 Gr	

Periphyton Assessment							
Stream: Waitoa Stream U/S		Date: 2/3/2016					
Sample Number: 2		Located number: 1249-121					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA		5				1
Medium mat/film (0.5-3mm thick)	Green (% cover)				40		8
	Light brown (% cover)	40	10	40	5	50	29
	Black/dark brown (% cover)						
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)			5			1
	Brown/Reddish (% cover)						
Submerged bryophytes	NA						
Iron Bacteria growths	NA						

Macrophyte recording sheet										
Stream: Waitoa Stream U/S			**Located number**: 1249-121				**Sample Number**: 2		**Date**: 2/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)							
			Total cover	Total submerged	Submerged plants				Emergent plants	
					Surface-reaching		Below surface			
					Sub-total	Species	Sub-total	Species	Total emergent	Species
1	1.6	6.4	62						62	Na 60, Ve 2
2	1.4	8.6	6						6	Na 5, Gr 1
3	1.1	4.3	2						2	Ve 1, Gr 1
4	1.7	7.7	3						3	Gr 3
5	1.5	4.4	50						50	Na 50

Periphyton Assessment							
Stream: Mangapapa Stream		Date: 3/3/2016					
Sample Number: 3		Located number: 433-14					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA						
Medium mat/film (0.5-3mm thick)	Green (% cover)						
	Light brown (% cover)						
	Black/dark brown (% cover)						
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)	15	10	10	60	50	29
	Brown/Reddish (% cover)						
Submerged bryophytes	NA	10	5	0	5	5	5
Iron Bacteria growths	NA						

Macrophyte recording sheet											
Stream: Mangapapa Stream			**Located number**:				**Sample Number**: 3			**Date**: 3/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants					Emergent plants		
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	Species		
1	4.9	6.5	0						0	
2	4	6.5	7						7	2 Gr, 5 Le = Lycopus europaeus, GYPSYWORT
3	2.66	6.8	3	1			1	Ec 1	2	Gr 2
4	3.1	7.7	17	10			10	Ec 5, Nh 5	7	Le 5, Ph 2
5	4.4	7.5	8	1			1	Ec 1	7	Le 5, Ph 2

Periphyton Assessment							
Stream: Waitakaruru Stream		Date: 4/3/2016					
Sample Number: 4		Located number: 1231-54					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA						
Medium mat/film (0.5-3mm thick)	Green (% cover)						
	Light brown (% cover)						
	Black/dark brown (% cover)						
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)	20	0	10	0	0	6
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Submerged bryophytes	NA						
Iron Bacteria growths	NA						

Macrophyte recording sheet										
Stream: Waitakaruru Stream			**Located number**: 1231-54				**Sample Number**: 4		**Date**: 4/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)							
			Total cover	Submerged plants					Emergent plants	
				Total submerged	Surface-reaching		Below surface			
					Sub-total	Species	Sub-total	Species	Total emergent	Species
1	2.1	3.7	45	10	10	Lm 10			35	Gr 20, Ph 10, Bf 5 = Bidens frondosa - BEGGAR'S TICKS
2	2.2	3.7	25				20	Pk	5	Gr 5
3	2.2	4.1	30				20	Lm	10	Gr 10
4	2.4	3.4	5						5	Gr 5
5	1.7	3.7	12				10	Lm	2	Gr 2

Periphyton Assessment							
Stream: Piakonui Stream		Date: 3/3/2016					
Sample Number: 5		Located number: 753-15					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA						
Medium mat/film (0.5-3mm thick)	Green (% cover)						
	Light brown (% cover)						
	Black/dark brown (% cover)						
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Submerged bryophytes	NA	20	10	20	30	5	17
Iron Bacteria growths	NA						

Macrophyte recording sheet										
Stream: Piakonui Stream			**Located number**: 753-15			**Sample Number**: 5			**Date**: 3/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)							
			Total cover	Submerged plants					Emergent plants	
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	Species		
1	3.6	4.4	0							
2	2.2	3.5	0							
3	2.4	3.4	0							
4	1.8	3.3	0							
5	5.5	7.2	0							

Periphyton Assessment							
Stream: Paiakarahi Stream D/S		Date: 3/3/2016					
Sample Number: 6		Located number: 718-5					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	5	5			5	3
Medium mat/film (0.5-3mm thick)	Green (% cover)						
	Light brown (% cover)						
	Black/dark brown (% cover)						
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Submerged bryophytes	NA						
Iron Bacteria growths	NA						

Macrophyte recording sheet										
Stream: Paiakarahi Stream D/S			**Located number**: 718-5				**Sample Number**: 6		**Date**: 3/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)							
			Total cover	Submerged plants					Emergent plants	
				Total submerged	Surface-reaching		Below surface			
					Sub-total	Species	Sub-total	Species	Total emergent	Species
1	3.7	9.2	0							
2	4.2	7.5	0							
3	3.1	6.1	0							
4	3	6.3	0							
5	5.3	6.8	0							

Periphyton Assessment							
Stream: Karengorengo Stream		Date: 2/3/2016					
Sample Number: 7		Located number: 232-3					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	0	0	0	0	0	0
Medium mat/film (0.5-3mm thick)	Green (% cover)						
	Light brown (% cover)						
	Black/dark brown (% cover)						
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)		20	20			8
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Submerged bryophytes	NA						
Iron Bacteria growths	NA						

Macrophyte recording sheet											
Stream: Karengorengo			**Located number**: 232-3				**Sample Number**: 7			**Date**: 2/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants						Emergent plants	
				Total submerged	Surface-reaching		Below surface			Total emergent	Species
					Sub-total	Species	Sub-total	Species			
1	2.5	3.5	10							10	Na 10
2	2.3	3.3	0								
3	1.8	4.25	0								
4	2.4	3.2	0								
5	2.6	4.7	10							10	Na 10

Periphyton Assessment							
Stream: Wairere		Date: 2/3/2016					
Sample Number: 8		Located number: 1224-5					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA						
Medium mat/film (0.5-3mm thick)	Green (% cover)						
	Light brown (% cover)	40	40	10	40	30	32
	Black/dark brown (% cover)						
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)	10	5	50	5	20	18
	Brown/Reddish (% cover)						
Submerged bryophytes	NA						
Iron Bacteria growths	NA						

Macrophyte recording sheet											
Stream: Wairere			**Located number**: 1224-5				**Sample Number**: 8			**Date**: 2/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants					Emergent plants		
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	Species		
1	6.2	7.5	6						6	Lp 5, Gr 1
2	6.3	7.5	2						2	Lp 1, Gr 1
3	5.9	8.5	3	1	1	Nh 1			2	Ph 2
4	6.1	8	2						2	Gr 2
5	5.2	7.5	2						2	Gr 2

Periphyton Assessment							
Stream: Waitearikiki Stream		Date: 4/3/2016					
Sample Number: 9		Located number: 1430-10					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA						
Medium mat/film (0.5-3mm thick)	Green (% cover)						
	Light brown (% cover)						
	Black/dark brown (% cover)	0	5	2	5	1	2.6
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)	1	0	15	10	5	6.2
	Brown/Reddish (% cover)						
Submerged bryophytes	NA						
Iron Bacteria growths	NA						

Macrophyte recording sheet										
Stream: Waiteariki Stream			**Located number**: 1430-10				**Sample Number**: 9		**Date**: 4/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)							
			Total cover	Submerged plants					Emergent plants	
				Total submerged	Surface-reaching		Below surface			
					Sub-total	Species	Sub-total	Species	Total emergent	Species
1	7.6	8.6	2						2	Gr 2
2	7	8.1	0						0	
3	16	18.2	1						1	Gr 1
4	6.1	7.3	2						2	Gr 2
5	6.3	7.3	2						2	Gr 2

Periphyton Assessment							
Stream: Waitawheta River		Date: 3/3/2016					
Sample Number: 10		Located number: 1235-11					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA		40	10			10
Medium mat/film (0.5-3mm thick)	Green (% cover)				40	60	20
	Light brown (% cover)	50					10
	Black/dark brown (% cover)						
Thick (>3mm) mat/film	Green/light brown (% cover)						
	Black/dark brown (% cover)						
Filaments short (<2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Filaments long (>2cm)	Green (% cover)						
	Brown/Reddish (% cover)						
Submerged bryophytes	NA						
Iron Bacteria growths	NA						

Macrophyte recording sheet											
Stream: Waitawheta River			**Located number**: 1235-11				**Sample Number**: 10			**Date**: 3/3/2016	
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants					Emergent plants		
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	Species		
1	5.7	6.5	5						5	5 Gr
2	3.3	4.5	25						25	25 Gr
3	4.2	4.9	5						5	5 Gr
4	3.2	4.3	0							
5	4.5.	5.5	5						5	5 Gr

Appendix D Macroinvertebrate taxa list

Species	Sites									
	1	2	3	4	5	6	7	8	9	10
Archichauliodes diversus	75	1		35	6	26		13	8	50
Antipodochlora braueri									2	
Xanthocnesis zealandica			1							
Ameletopsis percistus										1
Acanthophlebia cruentata	1				2					1
Atalophlebioides cromwelli					35					
Austroclima sp.			9	53	6		13		8	5
Austroclima jollyae										5
Austroclima sepia				18	4	13	4		8	20
Austronella planulata										
Deleatidium spp.	22	119			30	77		10	8	85
Coloburiscus humeralis					19	26		4	163	70
Neozephlebia scita	9				19					
Nesameletus sp.					4	48		21		35
Ichthybotus hudsoni	1									
Oniscigaster wakefieldi										
Rallidens mcfarlanei						13				
Zephlebia spp.		14		193	41	7	13	13	4	
Zephlebia inconspicua				158					17	
Zephlebia dentata	9	35	1	280	52		37	10		15
Zephlebia borealis	5				19					
Zephlebia spectabilis	1				13			1		25
Zephlebia versicolor					12					5
Zephlebia nebulosa					1					5
Austroperla cyrene										5
Megaleptoperla diminuta		5								
Megaleptoperla grandis										
Zelandobius spp.										
Zelandoperla decorata						16			6	5
Aoteapsyche catherinae		5	9			10			4	
Aoteapsyche colonica	5	1	9	70					17	5
Aoteapsyche raruraru			18							
Aoteapsyche spp.		5	9	70		4			23	25
Helicopsyche spp.	49									30
Hudsonema alienum										
Hudsonema amabilis	31	9			2		5	2		5
Hydrobiosella mixta										20

Species	Sites									
	1	2	3	4	5	6	7	8	9	10
Hydrobiosis spp.				18						10
Hydrobiosis copis										
Hydrobiosis parumbripennis										
Hydrobiosis gollanis										5
Neurochorema spp.										
Neurochorema armstrongi								2		
Neurochorema confusum										
Olinga feredayi	27	62								1
Orthopsyche sp.	9				8				10	20
Orthopsyche fimbriata					2					5
Orthopsyche thomasi					4					
Paroxyethira sp.									2	
Oxyethira albiceps		5	44			10	8	23	10	
Polyplectropus sp.					2					
Psilochorema sp.										
Pycnocentria sp.					4					
Pycnocentria evecta	9	18	289		4			6		30
Pycnocentrodes spp.	189	381	202	1120	4	64		12	23	15
Triplectides obsoleta/dolichos	9		9		4	4	2	10	6	
Zelolessia cheira									6	
Beraeoptera roria						13				
Elmidae (larvae)	14	53	1	1103	6	64		131	10	
Elmidae (adult)								1		
Hydraenidae (A)										
Ptilodactylidae (larvae)					1					
Scirtidae					2					
Rhantus sp.										
Aphrophila neozealandica						7			10	5
Limonia nigrescens	5									
Austrosimulium sp.	5	5	9	18	2	7			15	15
Chironomus zealandicus					2		2			
Corynoneura sp.										
Cricotopus sp.		5							4	
Eriopterini sp.	5									
Eukiefferiella sp.								2		
Harrisius pallidens					2					
Kaniwhaniwhanus sp.										
Lobodiamesinae								1		

Species	Sites									
	1	2	3	4	5	6	7	8	9	10
Macropelopiini sp.	9									
Orthocladiinae	5						2			
Empididae									2	
Muscidae							2			
Naonella forsythi									2	
Paradixa sp.	5									
Paralimnophila skusei										
Polypedilum spp.							28			
Tabanidae										
Tanytarsus spp.			1				2		15	10
Tanyderidae	5			1						
Zelandotipula sp.										
Potamopygrus antipodarum	329	342	2144	1453	61	268	160	117	50	500
Physa sp.			1	1						
Latia sp.	5	9		18		32				5
Lymnaea sp.										
Sphaerium sp.	1						4			
Oliogochatae unident	22				2		20			
Planaria	9			18						15
Ostracoda							8			
Hirudinea	5						2			
Paracalliope fluviatillis	44		1				7			
Paranephrops planifrons					8					