Waikato Regional Council Technical Report 2016/26

Waihou and Piako ecological monitoring 2015

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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April 2015

Document #:3379320

Peer reviewed by:
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Approved for release by:
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NIWA
Taihoro Nukurangi

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NIWA Client Report No:	HAM2015-036
Report date:	April 2015
NIWA Project:	EVW15209

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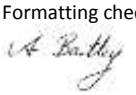

Executive summary

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 lower in 2015 than in 2014 except in the Mangapapa site, where more shortfin and longfin eels, as well as Cran's bullies, were observed in 2015. Inanga continued to be absent from all five sites (compared with being present at two of the sites in 2012). In the Waihou, the relative abundance of most fish species was also lower in 2015 than in 2014 at four of the five sites. In the Waitearikiki site, however, relative abundances of all species except brown trout were higher in 2015 than 2014. Banded kokopu were only found in one site in the Waihou catchment in 2015, whereas in 2014 they were observed in three sites.

Macroinvertebrate communities in the Piako sites improved in total taxonomic richness relative to previous surveys. Proportion EPT and MCI scores were more variable, declining in some sites and improving in others. In the Waihou catchment, macroinvertebrate communities also had greater taxonomic richness than in previous surveys, while %EPT remained similar. MCI scores, however, declined at two sites. In both catchments, the sites with declining macroinvertebrate communities had lower habitat quality scores, primarily due to a reduction in riparian vegetation and increased stream bank erosion or increased macrophyte and periphyton cover. In general, these impacts are associated with a reduction in the quality and diversity of the aquatic communities at these sites.

It is recommended that annual ecological monitoring continues at these ten sites. This will help to determine the inter-annual variability of native fish and macroinvertebrate populations over time, thus providing a more robust baseline against which to monitor the effects of human impacts on these river ecosystems over time. 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 (Waikato Regional Council 2012), hereafter referred to as the Plan. As required by the National Policy Statement for Freshwater Management (MfE 2011), the Plan includes minimum flow and allocation limits for all catchments in the region (Table 3-5; Waikato Regional Council 2012). Scheduled reviews of the flow and allocation limits are also specified in the Plan (Table 3-4A; Waikato Regional Council 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).

The objective 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 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 2015 during a period of sustained summer low flows (Table 2-1 & Figure 2-1). The sites were those sampled in 2014 following the recommendations of Franklin et al. (2013). The 2014 sampling had also been conducted in early March; consistency in sampling time is required for accurate comparisons of size distributions 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 2015 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

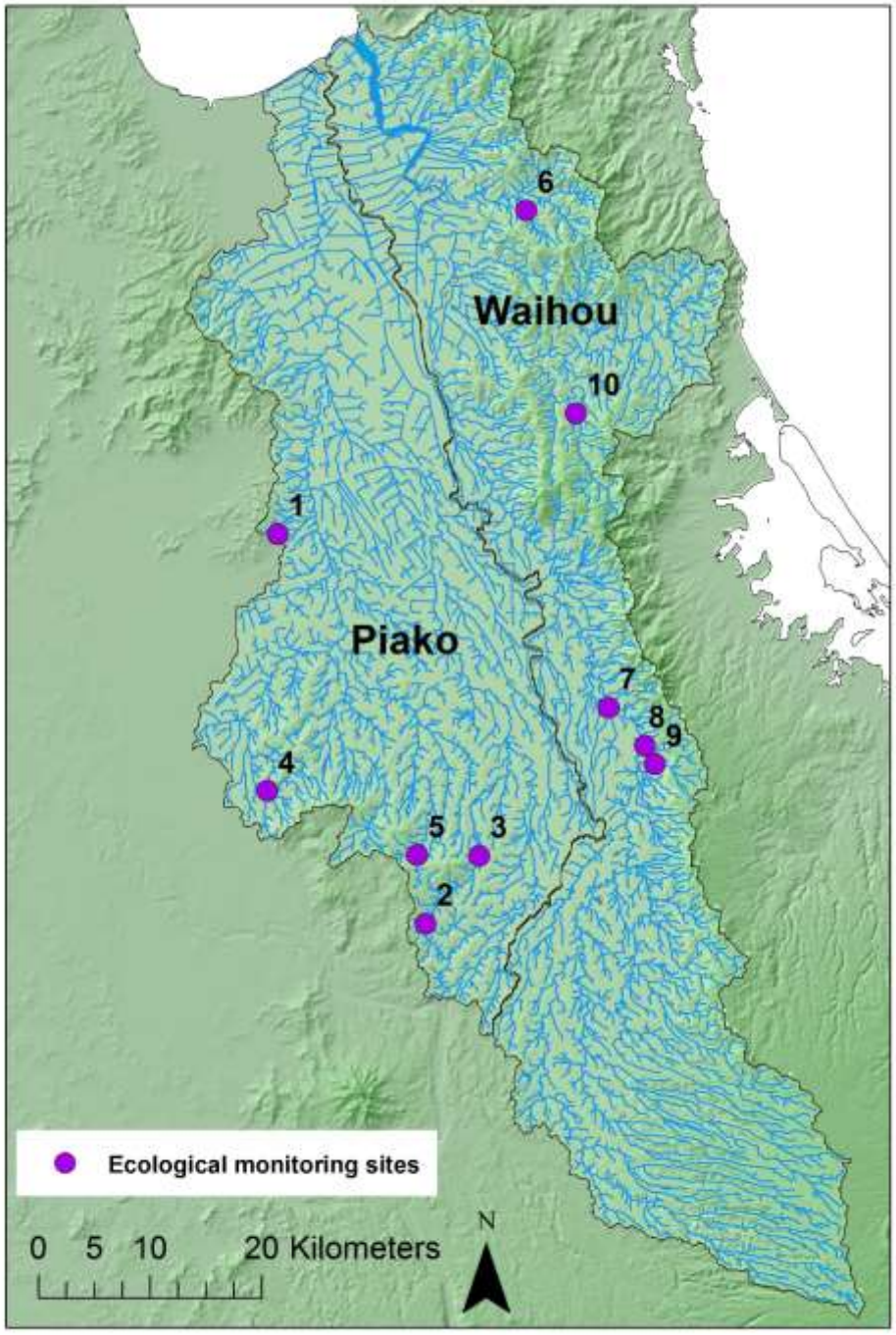

Figure 2-1: Location of the 10 ecological survey sites sampled in the Waihou and Piako catchments during 2014 and 2015. Site numbers refer to those listed in Table 2-1.

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 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

All six of the native fish species recorded across the five survey sites in the Piako catchment during the 2014 survey were captured in 2015 (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 (compared to five sites in 2014). Koura (*Paranephrops planifrons*), the freshwater crayfish, were recorded in four sites, whereas they were found in all five sites in 2014. Bullies were present at all sites in 2015, as they had been in 2014, 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. Similar to 2014, banded kokopu (*Galaxias fasciatus*) were captured in the Mangakahika and Piakonui, and torrentfish (*Cheimarrichthys fosteri*) were found in the Waitakaruru. Inanga (*Galaxias maculatus*) were absent from all five sites, although they were recorded at two sites (Mangapapa and Waitoa) in 2012.

The relative abundance of fish was lower in 2015 than in 2014 in Mangakahika Stream, Waitoa Stream, and Waitakaruru Stream, but higher in Mangapapa and Piakonui Streams (Figure 3-1). In the preparation of this year's report a mistake was discovered in the data entry for the 2014 surveys. As a consequence, the high abundances reported in Franklin et al. (2014) were erroneous. These data have been corrected in the current report and the results presented in Figure 3-1 should be used in future as the reference for fish abundance trends in the Piako catchment.

Species richness was lower in two sites, the Waitakaruru and the Waitoa, in 2015 compared to 2014 due to no longfin eels being caught at either site in 2015. Koura were common but had lower relative abundance in all sites compared to 2015. Koura were absent from the Mangakahika in 2015, although they were present in that site in 2014.

Fish length data provide information on fish recruitment and survival rates. A comparison of length-frequency relationships in 2014 and 2015 for shortfin eels and the two bully species at the Piako survey sites are shown in Figure 3-2. The remaining species were not captured in sufficient numbers for development of length-frequency relationships.

The abundance of shortfin eels was highest at the Waitoa site, followed by the Mangapapa and Waitakaruru sites, respectively. In 2014, the populations at these sites were dominated by eels <200 mm in length; in 2015 there were greater numbers of larger eels (200-400 mm in length) at most sites, particularly in the Waitakaruru (Figure 3-2). However, in 2015 elvers (juvenile eels) were often recorded as a unique category as they were too small to be identified as shortfins or longfins in the field (Table 3-1). Consequently, abundances of eels in the smallest size classes may be slightly under-represented in Figure 3-1, although unidentified elvers typically were a small proportion of the total eel abundance in each site (Table 3-1). In future surveys, a new technique developed by Waikato Regional Council using a mini aquarium will be employed to identify elvers >70 mm in the field.

The size distribution of shortfin eels was left-skewed in most sites, due to greater numbers of smaller eels than larger eels. This was particularly apparent for the 200-400 mm size class. This is considered consistent with habitat constraints (i.e., lack of large pools for large eels) and/or

downstream migration of adult male eels, which typically migrate at between 350-500 mm in length (Todd 1980). The Piakonui site, on the other hand, had no large eels, but more eels <200 mm in 2015 than in 2014 (Figure 3-2). This suggests that while juvenile recruitment is occurring in the Piakonui, habitat conditions may not be suitable at this site for supporting large eels. Intraspecific competition and commercial or traditional harvest pressure may also be factors that could contribute to reducing the number of large eels at this site.

There were fewer juvenile (<30 mm) Cran's bullies, more large adults (>50 mm) and a greater proportion of adults in the population at the three sites (Mangapapa, Waitakaruru and Waitoa) where they are present in 2015, compared to 2014 (Figure 3-2). This indicates lower recruitment than the previous year, but increased survival of adults. At the two sites where common bullies were present (Mangakahika and Piakonui), the size structure of the population varied between 2014 and 2015, which is likely to be due to the diadromous lifecycle of this species where recruitment can be inconsistent between years. For example, there were more juveniles in the Mangakahika in 2015 than in 2014. In contrast, there were fewer small fish and more large fish in the Piakonui in 2015 than in 2014. This suggests that this population is primarily sourced by migration/re-distribution within the stream, rather than recruitment, a conjecture supported by the absence of common bullies in the Piakonui prior to 2014.

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, which may relate to either poor recruitment of this species, or an artefact of the limited sampling, as longfin elvers tend to be more discrete in their distribution compared to shortfins.

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

Site	Shortfin eel		Longfin eel		Elver		Cran's bully		Common bully		Torrentfish		Banded kokopu		Koura	
	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.
1. Mangakahika Stream	18	7.3	1	0.4	3	1.2	-	-	7	2.9	-	-	30	12.2	-	-
	31	13.7	8	3.5	-	-	-	-	21	9.3	-	-	27	11.9	7	3.1
2. Waitoa Stream	80	41.3	-	-	22	11.4	67	34.6	-	-	-	-	-	-	10	5.2
	120	49.1	6	2.5	-	-	135	55.2	-	-	-	-	-	-	59	24.1
3. Mangapapa Stream	36	7.3	5	1	7	1.4	104	21	-	-	-	-	-	-	11	2.2
	26	4.8	3	0.6	-	-	91	16.6	-	-	-	-	-	-	31	5.7
4. Waitakaruru Stream	30	8.7	-	-	4	1.2	63	18.3	-	-	3	0.9	-	-	14	14.1
	89	29.7	10	3.3	-	-	88	29.3	-	-	1	0.3	-	-	38	12.7
5. Piakonui Stream	13	4.1	4	1.3	6	1.9	-	-	21	6.7			5	1.6	83	26.5
	7	1.9	4	1.1	-	-	-	-	22	6.0	-	-	4	1.1	200	54.6

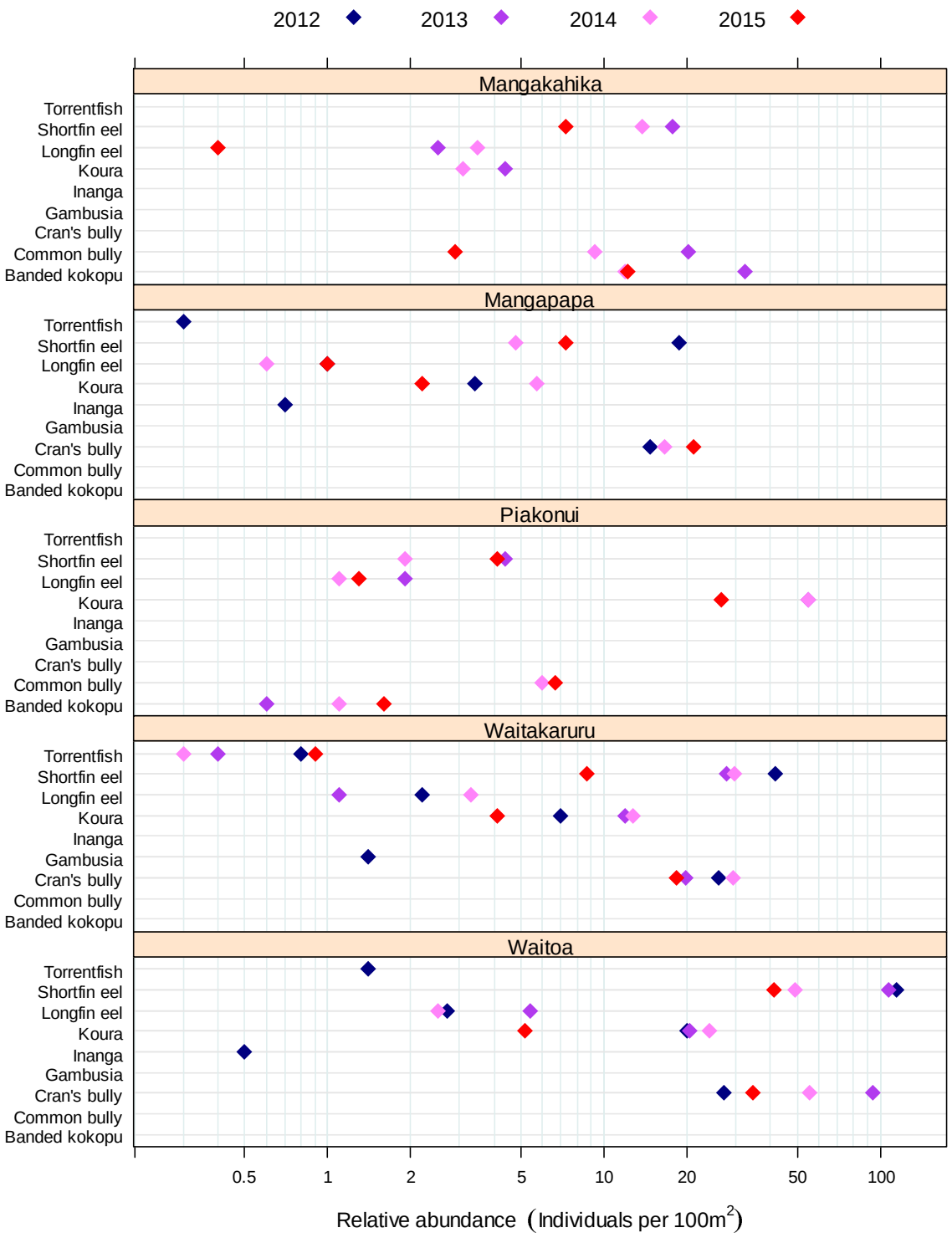

Figure 3-1: Comparison between the relative abundance of fish captured in the 2012 – 2015 Piako surveys. The Mangakahika Stream and Piakonui sites were not surveyed in 2012. The Mangapapa Stream at this location was not surveyed in 2013. Note the logarithmic x-axis.

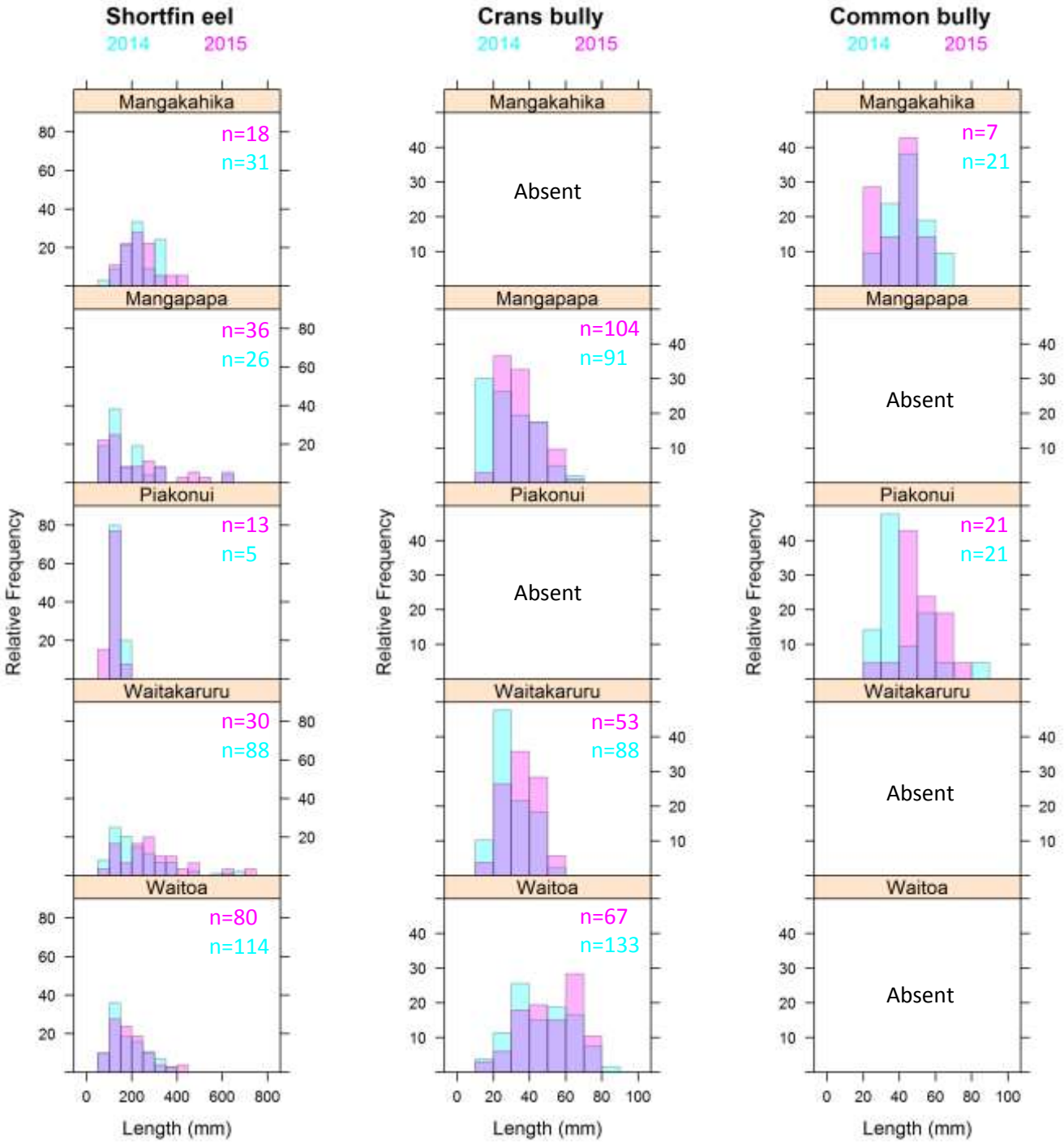

Figure 3-2: Length-frequency relationships for the most abundant fish species at each site in the Piako catchment. Relative frequency (proportion of total individuals) size distributions for 2014 are shown in blue and size distributions for 2015 are shown in pink. The purple areas indicate where distributions overlapped between the two years.

3.1.2 Macroinvertebrates

All sites were sampled according to 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 3-2 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 3-2) 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 in 2015 compared to 2014, with the greatest increases in the Mangakahika, Mangapapa, and Piakonui sites (Table 3-2). MCI scores at those sites, however, were lower in 2015 than 2014, indicating that the additional species were pollution-tolerant and thus the increased richness was not necessarily indicative of improvements in water quality.

As in 2014, the Piakonui site had the highest total taxa richness and EPT richness in 2015; the %EPT and MCI scores were also highest at this site (Table 3-2). The Mangapapa site had the lowest taxonomic richness in both 2014 and 2015 (Table 3-2), which is likely to be because of the high proportion of bedrock substrate at this site. However, both the number of EPT taxa and the %EPT in the Mangapapa were higher in 2015 than 2014, particularly %EPT, indicating an improvement in the macroinvertebrate community, despite a 'poor' MCI score (Figure 3-3). MCI scores varied only slightly between 2014 and 2015 in the Piakonui and the Waitakaruru survey sites, which remained 'excellent' and 'fair,' respectively (Figure 3-3). The MCI score declined from 'good' to 'fair' in the Mangakahika and from 'good' to 'poor' in the Mangapapa. The Waitoa site MCI score, on the other hand, improved from 'good' to 'excellent' between 2014 and 2015 (Figure 3-3). The improved MCI score in the Waitoa site may be linked to the reduced coverage by aquatic macrophytes observed in this site in 2015 (see Figure 3-4).

Table 3-2: Summary of macroinvertebrate results for the Piako monitoring sites in 2015. The results from 2015 are in blue; the results from the 2014 survey 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	Total taxa richness	EPT richness	%EPT	MCI
1. Mangakahika Stream	27	10	24.1	100
	20	11	58.7	107.0
2. Waitoa Stream	17	11	77.2	130.6
	15	10	69.9	113.3
3. Mangapapa Stream	13	8	38.7	76.9
	9	6	2.0	106.7
4. Waitakaruru Stream	14	7	15.9	94.3
	13	5	38.6	90.8
5. Piakonui Stream	34	20	86.8	134.1
	28	15	83.5	137.1

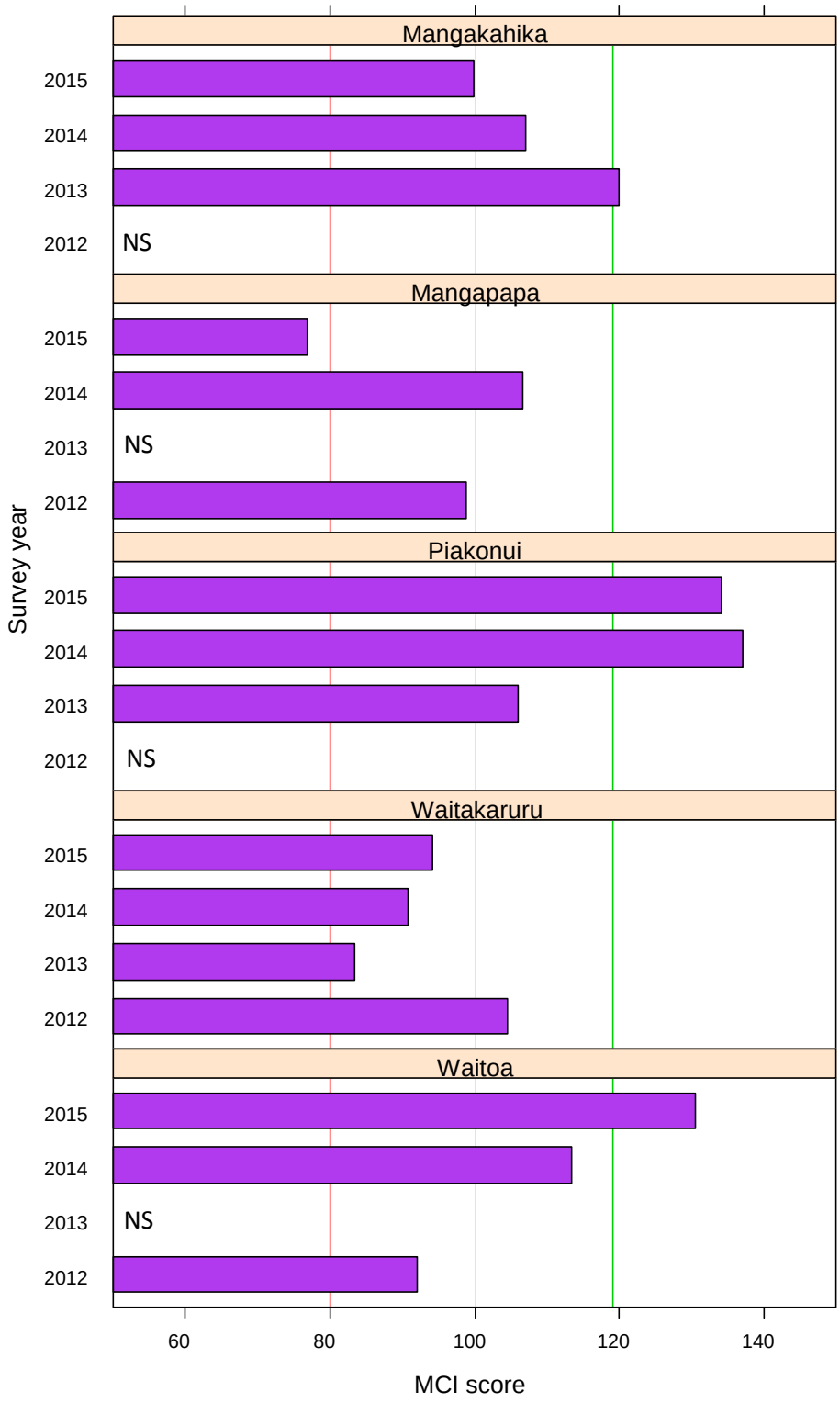

Figure 3-3: Comparison of MCI scores between survey years in the Piako catchment. Vertical lines indicate boundaries for quality classes. Anything below the red line is 'poor', between the red and yellow lines is 'fair', between the yellow and green lines is 'good' and above the green line is 'excellent' (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 3-4). However, in the Waitakaruru site, there was a significant increase in the macrophyte cover in 2015 compared to 2014, which was in turn greater than in previous years (Figure 3-4). The increase in macrophyte cover in the Waitakaruru was largely due to expansion of submerged exotics *Lagarosiphon major* and *Potamogeton crispus*. The Waitoa site, on the other hand, had lower macrophyte cover in 2015 than 2014, although macrophyte cover in 2015 was still significantly higher than it had been in years prior to 2014. The predominant macrophyte cover in the Waitoa in both 2014 and 2015 was watercress (*Nasturtium officinale*).

The periphyton enrichment (PEI) and sliminess (PSI) indices have remained relatively stable over time at the Piakonui, Mangakahika and Mangapapa sites (Figure 3-5 & Figure 3-6). In the Waitakaruru and Waitoa sites, the PEI scores were significantly higher in 2014 than in previous years, but decreased again between 2014 and 2015 (Figure 3-5). In the Waitakaruru, the 2015 PEI score was still higher than in all other previous years except 2014 (Figure 3-5). Given the concurrent increase in macrophyte growth at this site, this may be indicative that increasing eutrophication (nutrient enrichment) is occurring in this stream. However, in the Waitoa, the PEI score for 2015 was the lowest yet recorded for that site. Macrophyte cover also declined in the Waitoa between 2014 and 2015, indicating that the effects of eutrophication may have slowed at this site. The PSI scores were significantly lower in both sites in 2015 compared to 2014, largely due to decreased amounts of filamentous algae.

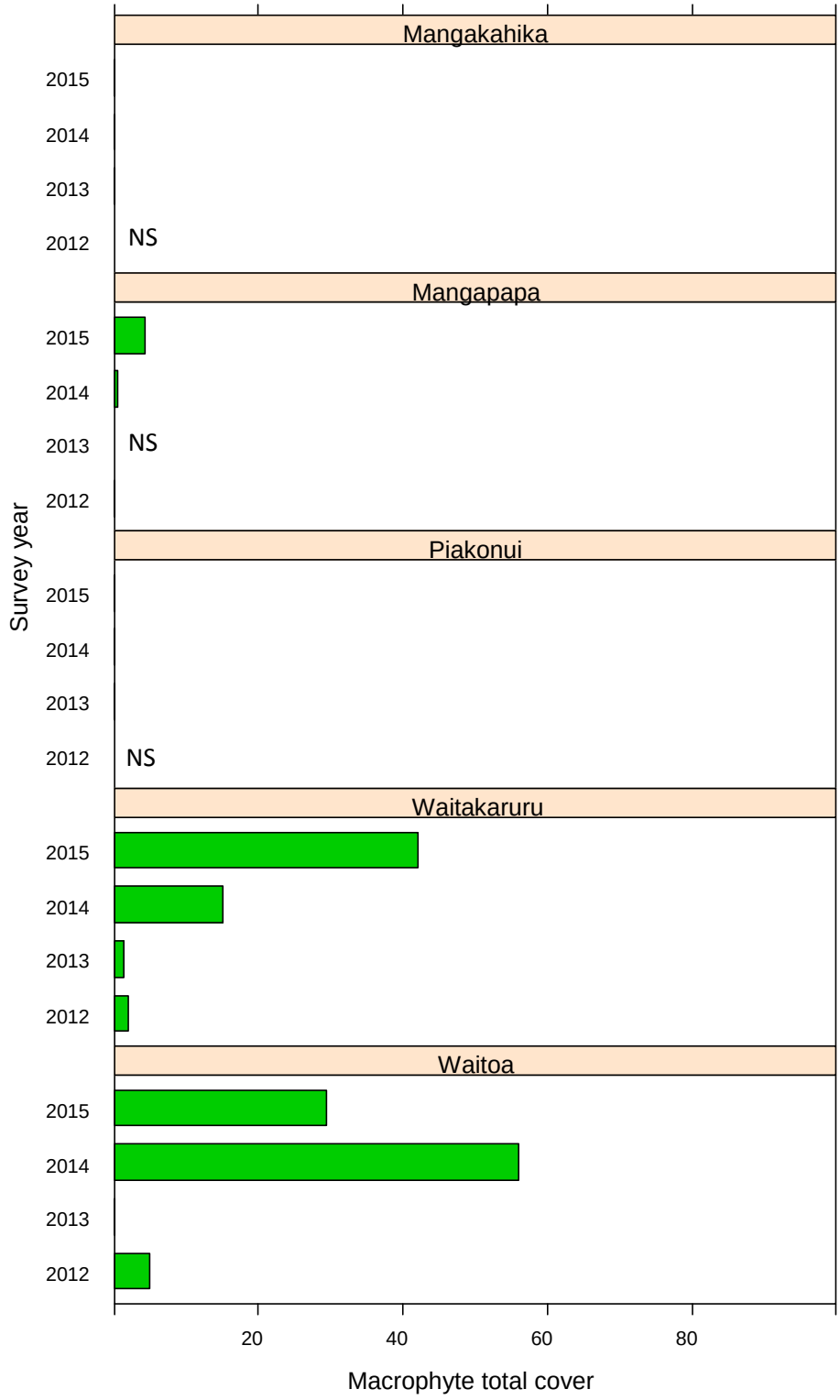

Figure 3-4: Comparison of macrophyte total cover (MTC) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

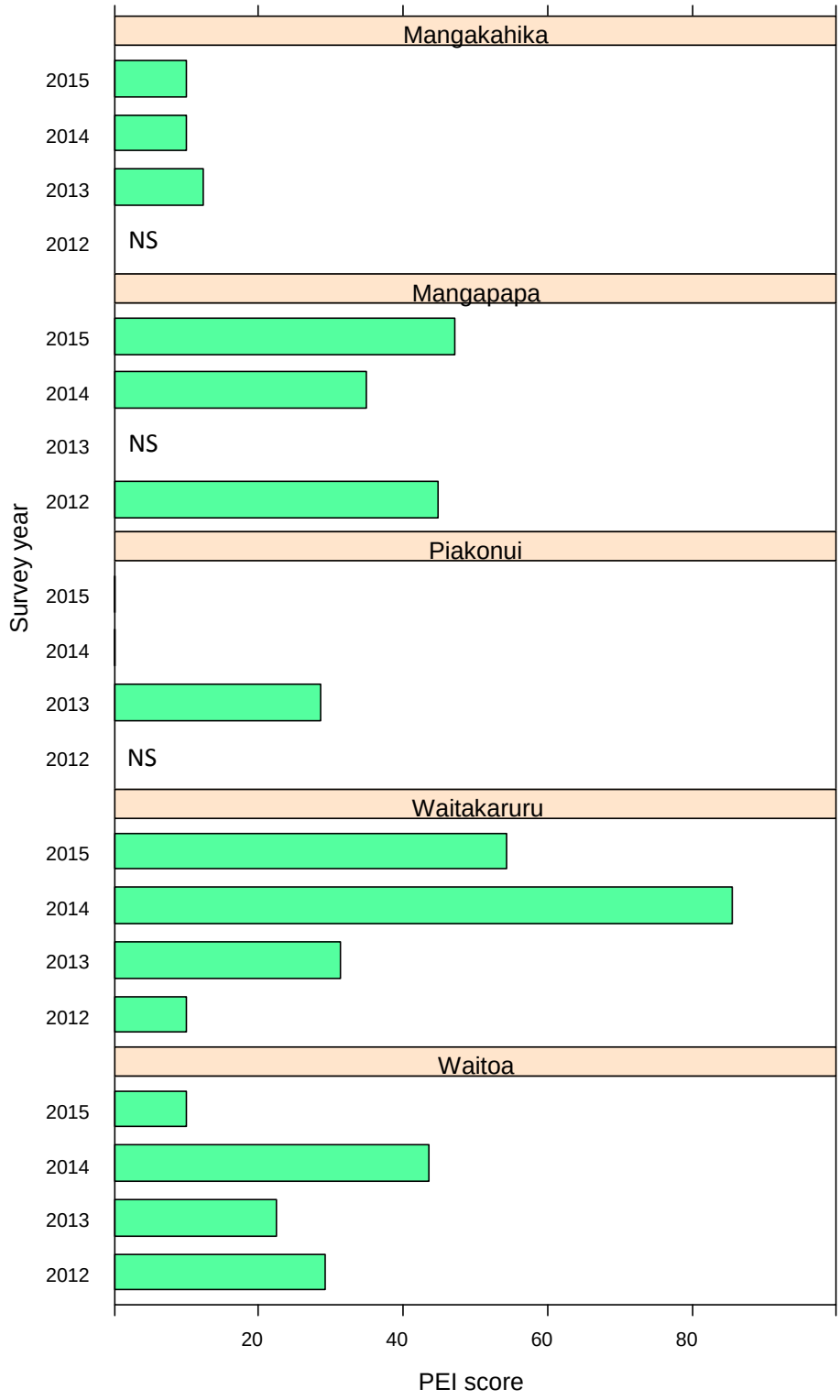

Figure 3-5: Comparison of periphyton enrichment index (PEI) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

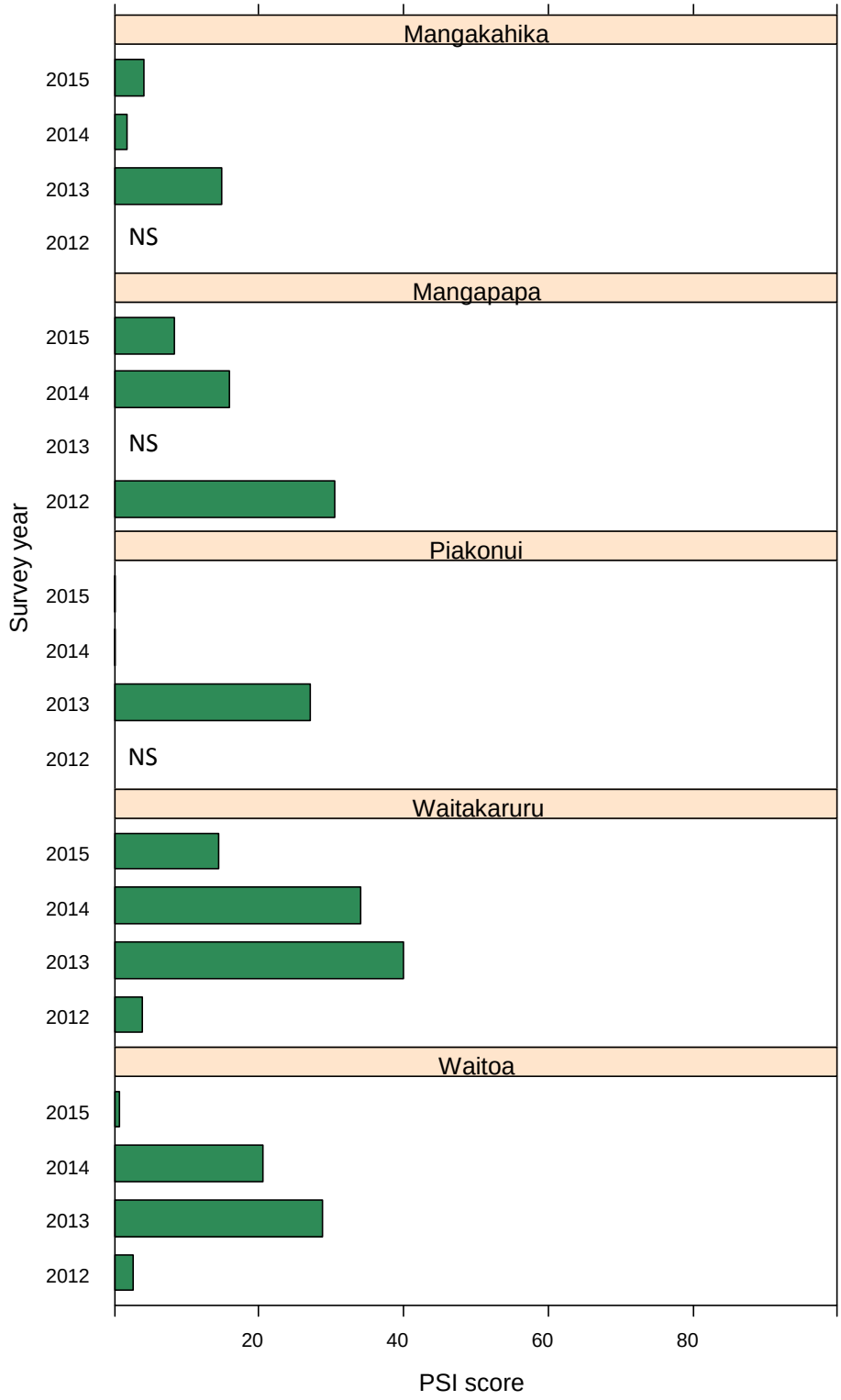

Figure 3-6: Comparison of periphyton sliminess index (PSI) scores over time at the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

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 Mangapapa and Piakonui sites have remained relatively stable between surveys to date (

Figure 3-7). However, there has been a gradual decline in scores in the Mangakahika and Waitakaruru sites (

Figure 3-7). Both of these sites lack 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, but improved slightly in 2015. This improvement was largely due to increased bank stability, potentially indicating less damage by cattle, although fencing is also absent at this site.

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=16). 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=0.51; Figure 3-8). In both 2014 and 2015, the Waitoa site had low habitat scores but high MCI scores, suggesting that this site may be a potential outlier, and that the low habitat scores are not associated with organic pollution. The correlations between habitat score, total macroinvertebrate richness and fish species richness were also positive, although not as strong (ρ=0.38 and ρ=0.42, respectively; Table 3-3).

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

Biotic index	Spearman's rank correlation coefficient
MCI	0.51
Macroinvertebrate total richness	0.38
EPT richness	0.45
% EPT	0.33
Fish richness	0.42

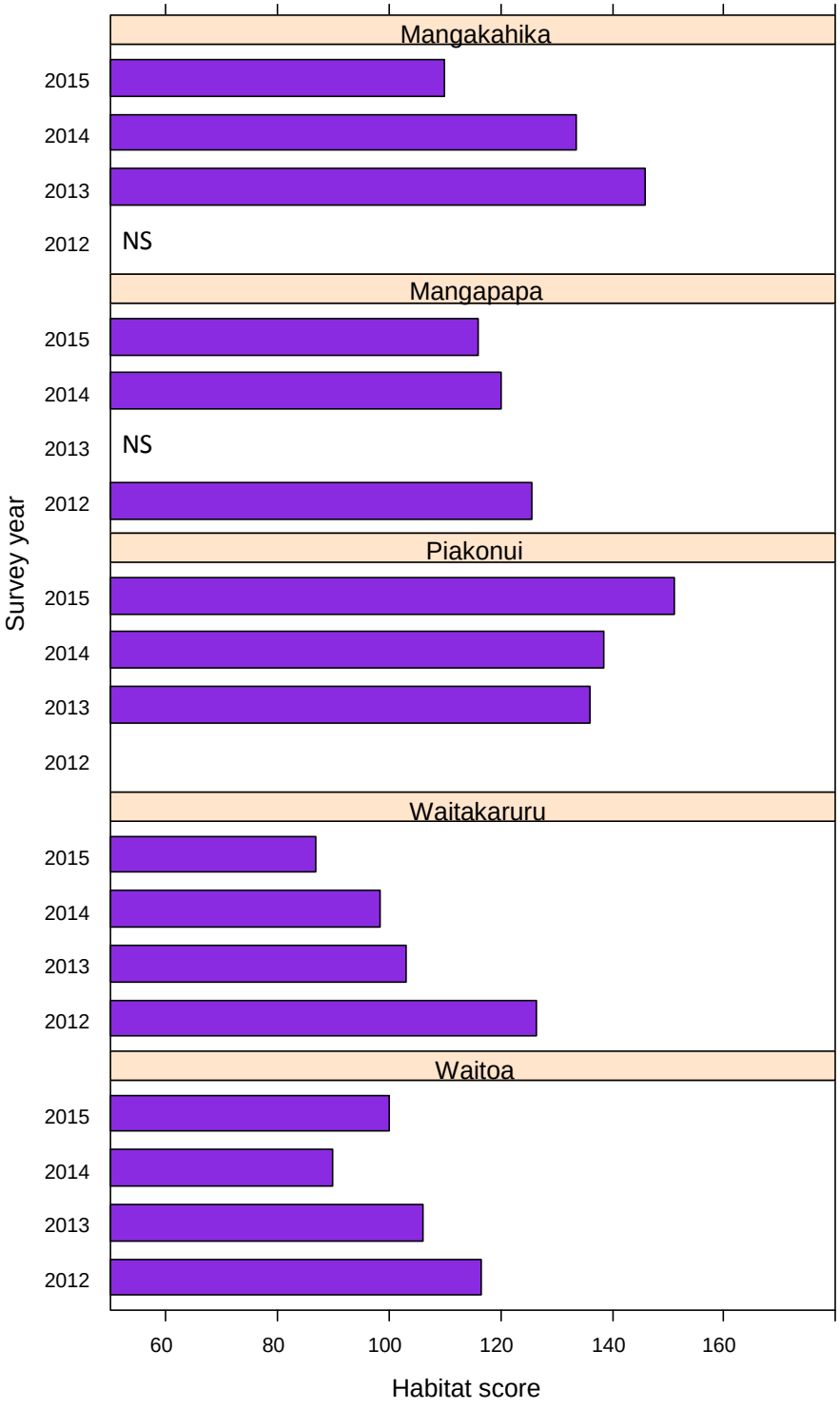

Figure 3-7: Comparison of habitat scores over time for the Piako survey sites. Years in which a site was not surveyed are marked 'NS.'

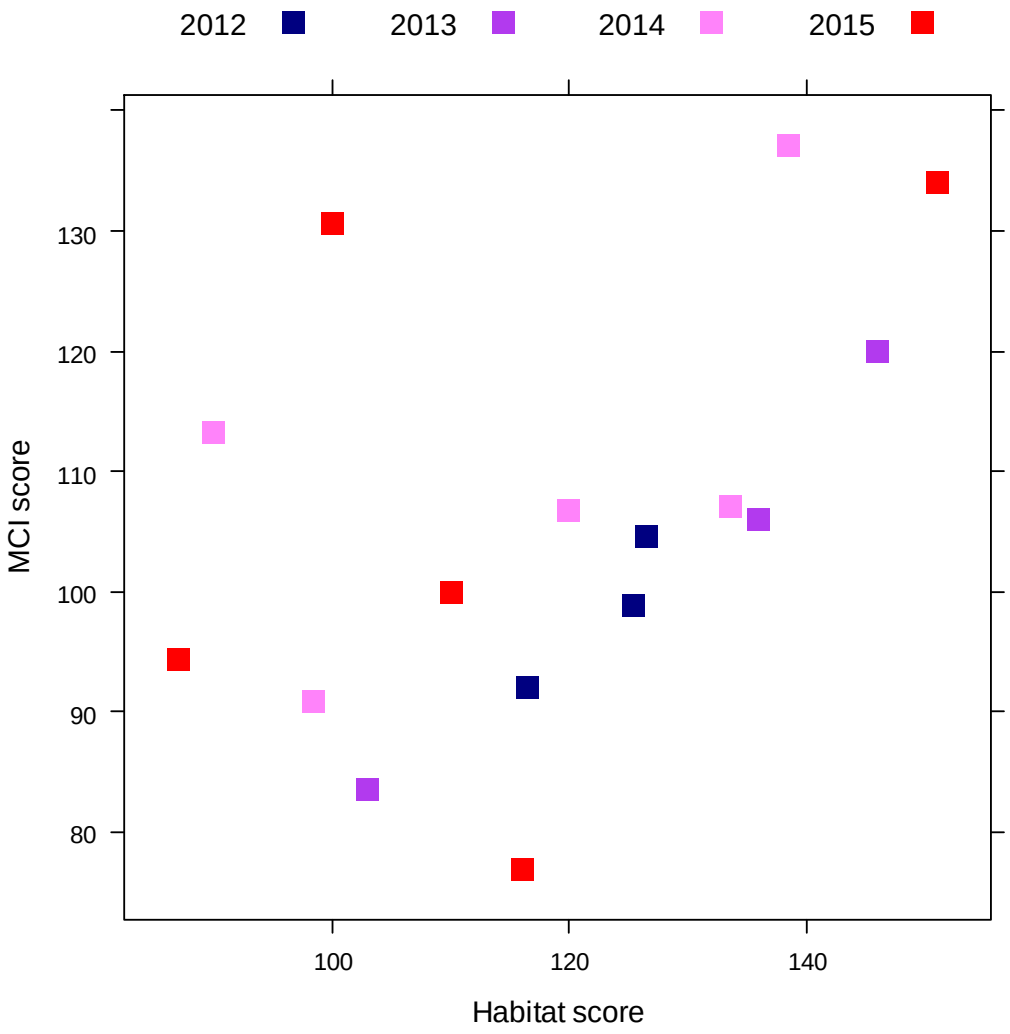

Figure 3-8: Scatterplot of habitat score against MCI score at the Piako survey sites in different survey years (ρ=0.51). No MCI score was available for the Waitoa site in 2013.

3.2 Waihou catchment

3.2.1 Fish

Ten different fish species were recorded among the five Waihou survey sites in 2015, eight of which were native alongside two exotic species; rainbow and brown trout (Table 3-4). Shortfin eels were the only species present at all five sites, with longfin eels and brown trout (*Salmo trutta*) all recorded at four sites. Koura (freshwater crayfish), were also present at all five sites and freshwater shrimp (*Paratya curvirostris*) were found at two sites. Banded kokopu were only captured at one site in 2015, compared to three sites in 2014. However, inanga were found at two sites in 2015, an increase from one site in 2014. The greatest species richness (8) was recorded in the Paiakarahi 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 3-4). The greatest abundance of fish was recorded from the Wairere Stream site, where large numbers of both shortfin eels and common bullies were captured, although less than half as many as were recorded in 2014. (*Authors' note:* the abundances for 2014 have been corrected from last year's report, and Figure 3-9 from this report should be used in future as the reference for fish abundance trends in the Waihou catchment).

The relative abundance of fish is compared between survey years for each site in Figure 3-9. 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 in 2015 was about half of that recorded in 2014 and more comparable to the 2009 to 2013 surveys (Figure 3-12). Consequently, the numbers of fish captured in 2015 were higher than those seen in 2014 and more comparable to that recorded in earlier surveys. However, the reduced macrophyte cover was not associated with increased capture of longfin eels (none present in 2015) or inanga (one present in 2015), both of which were found in surveys prior to 2014.

At the Paiakarahi sampling site, the abundance of torrentfish, banded kokopu, rainbow trout, and Cran's bullies were lower in 2015 than in any of the previous surveys (Figure 3-9). However, both shortfin and longfin eel abundances in the Paiakarahi in 2015 were comparable to those observed in past years. Brown trout were also found for the first time at this site.

At the Wairere Stream site, the abundance of both shortfin eels and common bullies was lower in 2015 than in 2014, when large numbers of juvenile fish were captured, but higher than the other previous survey in this site (Figure 3-9). However, greater numbers of torrentfish and brown trout were caught in 2015 compared to 2014. Longfin eel abundances were lower than in all previous surveys, and inanga continued to be absent (only recorded in the 2011 survey).

At the Waitearikiki survey site, the numbers of fish recorded in 2015 were generally similar to those in both previous surveys (Figure 3-9). Shortfin eel, Cran's bully, and torrentfish abundances were all higher in 2015 than in 2014. Fewer brown trout were caught in 2015, but rainbow trout were observed for the first time. Banded kokopu were absent again after being recorded for the first time in 2014.

At the Waitawheta site, fewer shortfin eels, but more longfin eels were recorded in 2015 compared to 2014. Koura abundance was also substantially higher than the previous year. Brown trout abundance, however, was lower in 2015, and no banded kokopu were captured (a single individual was caught in 2014).

Length-frequency relationships show that there were fewer shortfin eels in the smallest size classes and more in the 150-250 mm size range at all sites in 2015 compared to 2014 (Figure 3-10). At the Wairere site, 34 juvenile eels were identified only as 'elvers,' and therefore the smallest size class for one or both eel species may be under-represented in this site. There were very few shortfin eels >250 mm at any site. Given the presence of large longfin eels at most of these sites, this suggests that instream habitat may be more suited to longfin eels (i.e. hard substrate) rather than shortfin eels.

The longfin eel populations at each site were primarily comprised of fish of >300 mm in length. In combination with the scarcity of longfin elvers (only 3 longfin eels <200 mm were caught; 2 in the Paiakarahi and 1 in the Waitearikl), this may be an indicator of poor recruitment of this species in recent years.

There were more small (<30 mm) bullies of both species in 2015 than 2014 in all but one site, indicating good juvenile recruitment (Figure 3-10). However, there were also fewer large bullies (>70 mm) in 2015, suggesting decreased survival. This could be a consequence of the relatively low flows noted at several sites, but may also reflect natural inter-annual variations in recruitment and population structure. At the Wairere site, there were fewer small bullies and more in the 30-60 mm size range in 2015 compared to 2014. This reflects the high abundance of juvenile bullies at this site in 2014, now in the 30-60 mm size class, which would naturally reduce in numbers over time as they grow. The relative abundance of bullies in the Wairere stream was much lower in 2015 than in 2014.

Table 3-4: Results of 2015 electric fishing survey at the five Waihou catchment monitoring sites.

Ab. = Number caught; Rel. Ab. = Relative abundance (Individuals per 100 m^2). The results from 2015 are in blue; the results from the 2014 survey are included in black for comparison.

Site	Shortfin eel		Longfin eel		Elver		Cran's bully		Common bully		Torrentfish		Inanga		Smelt		Banded kokopu		Rainbow trout		Brown trout		Unident. trout		Koura	
	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.	Ab.	Rel. Ab.
6. Paiakarahi Stream	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
	8	1.6	8	1.6	-	-	64	13	-	-	5	1	1	0.2	-	-	1	0.2	3	0.6	-	-	-	-	32	6.5
7. Karengorengo Stream	98	32	-	-	-	-	-	-	17	5.6	-	-	1	0.3	24	7.8	-	-	-	-	-	-	4	1.3	31	10.1
	33	9.1	-	-	-	-	-	-	3	0.8	-	-	-	-	2	0.6	-	-	-	-	1	0.3	-	-	9	2.5
8. Wairere Stream	148	17.5	1	0.1	34	4	-	-	208	24.6	2	0.2	-	-	-	-	-	-	3	0.4	5	0.6	-	-	15	1.8
	254	31.1	2	0.3	-	-	-	-	965	118	1	0.1	-	-	-	-	-	-	-	-	1	0.1	-	-	58	7.1
9. Waiteariki Stream	51	5.5	15	1.6	-	-	87	9.4	-	-	2	0.2	-	-	-	-	-	-	1	0.1	1	0.1	-	-	125	13.5
	20	2.1	10	1.1	-	-	47	5	-	-	1	0.1	-	-	-	-	7	0.7	-	-	6	0.6	-	-	88	9.4
10. Waitawheta River	12	2.9	17	4	-	-	-	-	53	12.6	-	-	-	-	-	-	-	-	-	-	1	0.2	-	-	25	6
	23	4.5	16	3.1	-	-	-	-	64	12.6	-	-	-	-	-	-	1	0.2	-	-	3	0.6	-	-	10	2.0

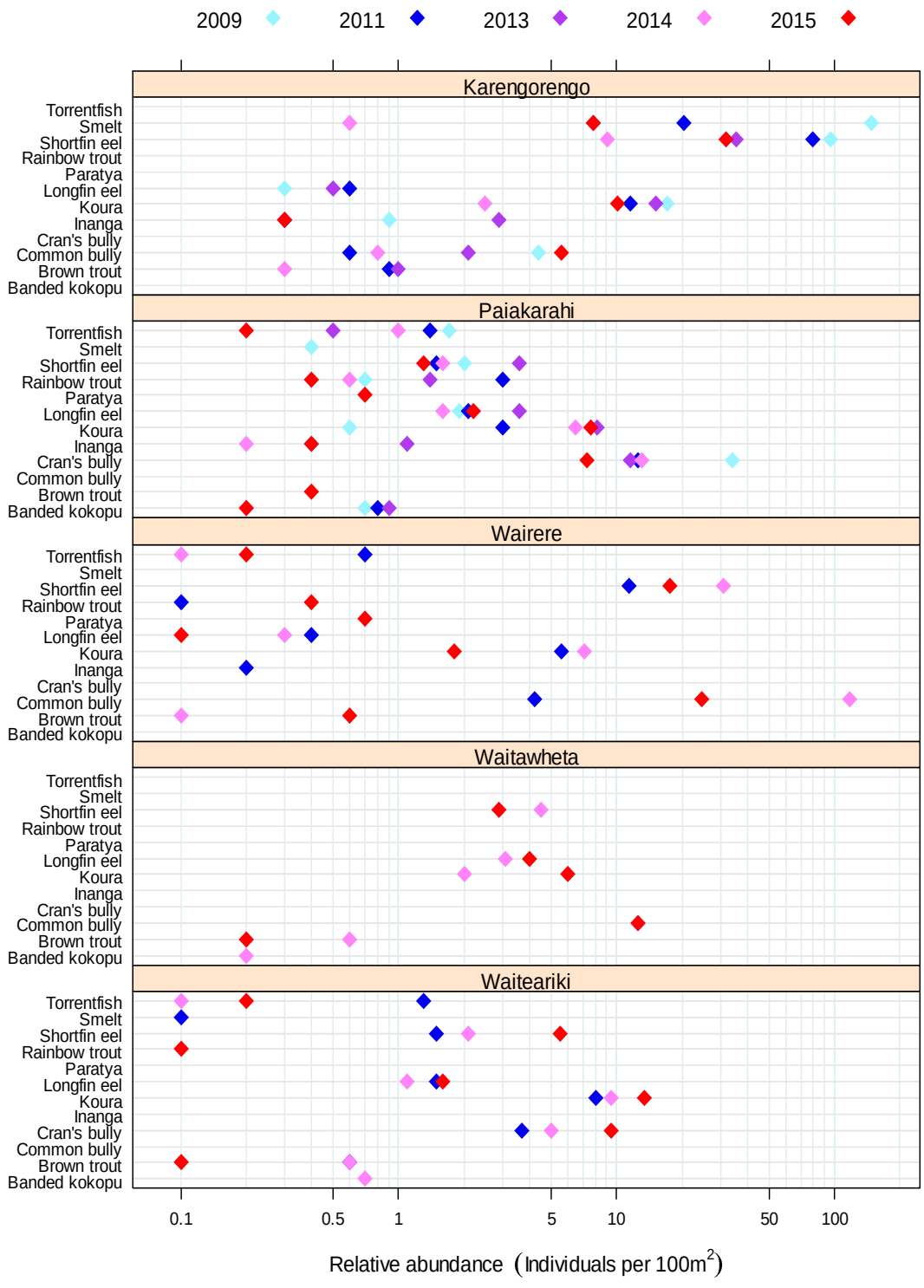

Figure 3-9: Comparison between the relative abundance of fish captured in the 2009, 2011, and 2013 - 2015 Waihou surveys. Wairere Stream and Waiteariki Stream were only sampled in 2011, 2014, and 2015. The Waitawheta was only sampled in 2014 and 2015. Note the logarithmic x-axis.

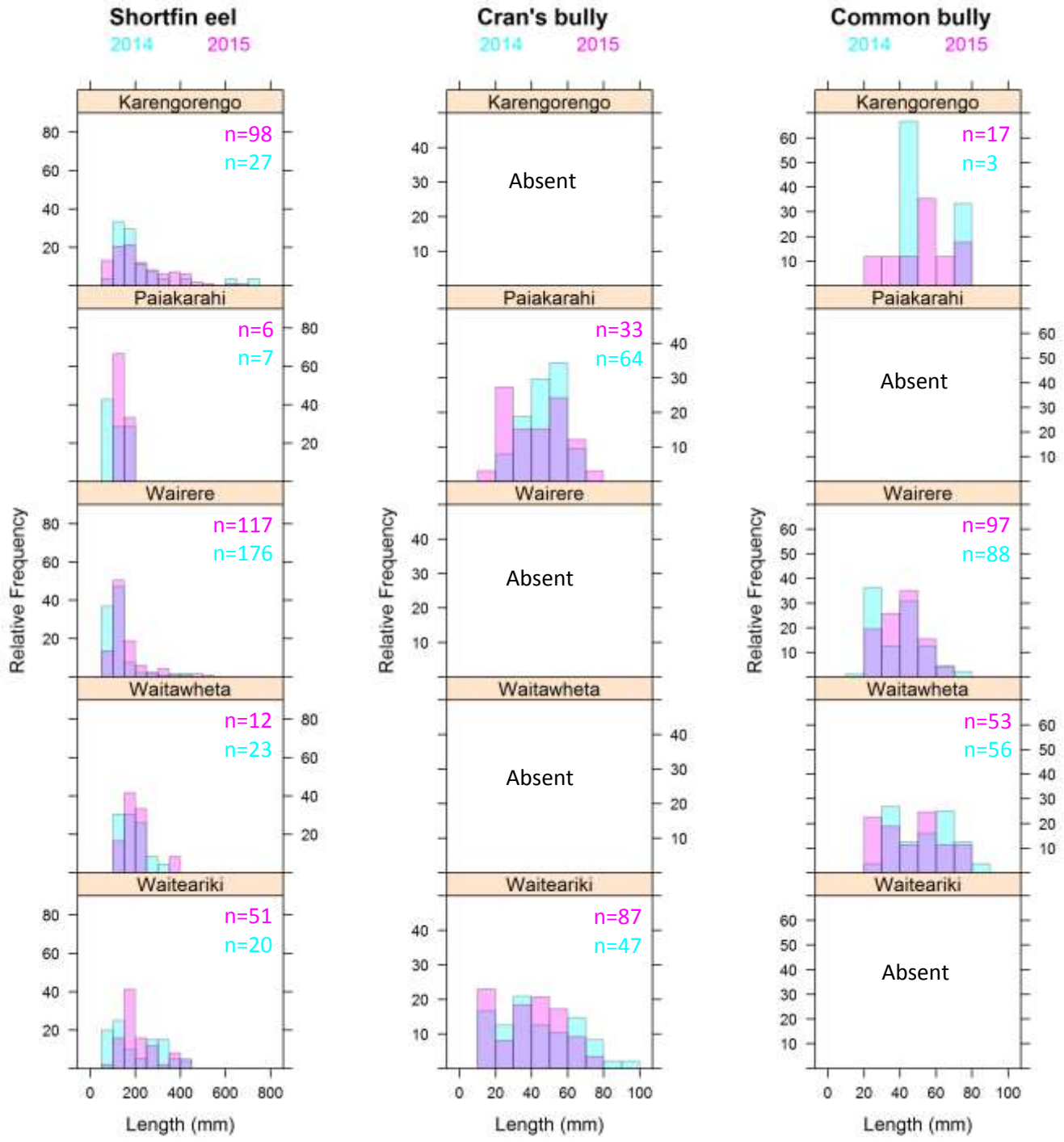

Figure 3-10: Length-frequency relationships for the most abundant fish species at each site in the Waihou catchment. Relative frequency (proportion of total individuals) for 2014 are shown in blue and size distributions for 2015 are shown in pink. The purple areas indicate where distributions overlapped between the two years.

3.2.2 Macroinvertebrates

Taxa richness was good at all Waihou sites, and the 2015 richness was the highest yet recorded in four of the five sites (Table 3-5). However, %EPT scores were relatively low for the Waitawheta and Karengorengo sites, due to the high abundance of *Potamopyrgus* in these sites. Nonetheless, the Waitawheta site the highest MCI score and was the only site to fall in the 'Excellent' quality class in both 2015 and 2014 (Figure 3-11).

MCI scores improved in the Paiakarahi and Wairere sites; both these sites were in the 'Good' class. Total taxa richness and EPT richness also doubled in both these sites between 2014 and 2015. The MCI score for the Waiteariki site declined slightly between 2014 and 2015, but stayed in the 'Good' quality class. The Karengorengo site MCI score was also lower in 2015, though it retained its 'Fair' classification (Figure 3-11).

The low MCI score for the Paiakarahi site in 2014 was attributed to increased periphyton cover, which is supported by this year's data, as periphyton cover was reduced (Figure 3-13) and the MCI score improved. However, the Wairere site also had an improved MCI score despite an increase in periphyton cover in the reach, and the Waiteariki site score declined despite having much lower periphyton in 2015. This indicates that periphyton cover may not be the main factor driving changes in MCI scores. At the Karengorengo site, changes in habitat are likely to be a contributing factor to the decline in the MCI score. The habitat score also dropped substantially between 2014 and 2015 at this site, due to reduced riparian vegetation and corresponding stream bank instability and erosion.

Table 3-5: Summary of macroinvertebrate results for the Waihou monitoring sites in 2015. The results from 2015 are in blue; the results from the 2014 survey 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	Total taxa richness	EPT richness	%EPT	MCI
6. Paiakarahi Stream	32	19	61.6	111.3
	18	9	50.2	105.6
7. Karengorengo Stream	22	7	22.1	82.7
	18	7	22.1	97.8
8. Wairere Stream	32	20	51.2	116.8
	17	10	35.2	101.2
9. Waiteariki Stream	26	13	74.2	111.5
	29	20	78.3	117.2
10. Waitawheta River	31	22	25.6	134.2
	29	21	23.5	125.5

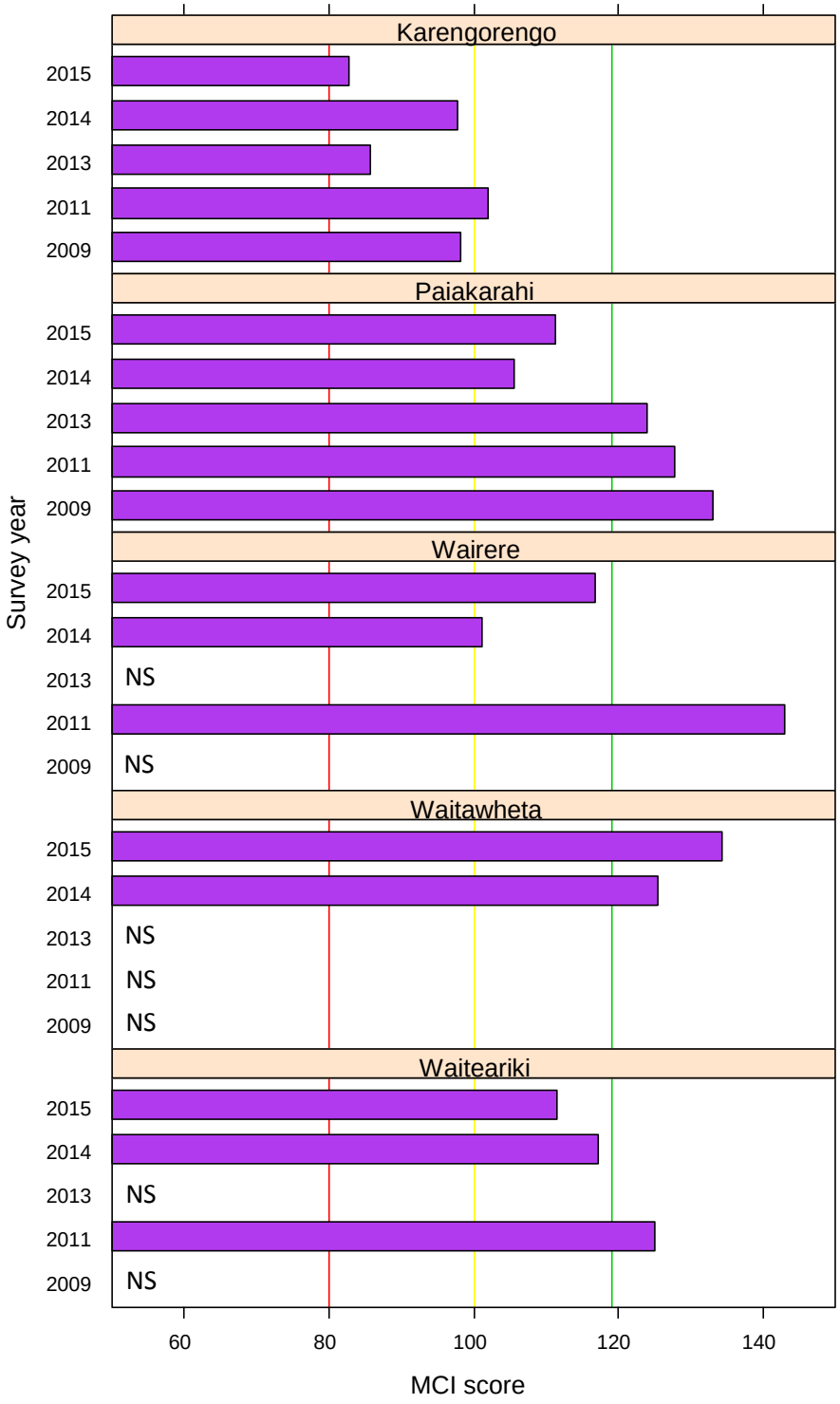

Figure 3-11: Comparison of MCI scores between survey years in the Waihou catchment. Vertical lines indicate boundaries for quality classes. Anything below the red line is 'poor', between the red and yellow lines is 'fair', between the yellow and green lines is 'good' and above the green line is 'excellent' (Stark & Maxted 2007). Years in which a site was not surveyed are marked 'NS.'

3.2.3 Macrophytes & periphyton

Macrophyte cover is low at all the Waihou survey sites except the Karengorengo Stream (Figure 3-12). At the Karengorengo site, macrophyte cover progressively increased from 2009 to 2014, when the whole channel was clogged with macrophytes (MTC = 98%). However, in 2015 macrophyte cover was reduced approximately 50% (MTC = 45%) from the previous year. This is the lowest macrophyte cover observed since 2011. The emergent species *Apium nodiflorum* remains the dominant macrophyte present in the reach.

Periphyton enrichment scores (PEI) were higher than 2014 in the Wairere and Waitawheta sites and lower in the Paiakarahi and Waiteariki sites. Interestingly, PSI scores were the opposite; the PSI score was higher in the Paiakarahi in 2015 compared to 2014, but lower in the Wairere and Waitawheta. This indicates that there was an increase in long filamentous algae in the Wairere and Waitawheta, and a shift towards greater coverage by thin film algae in the Paiakarahi.

This was also the first year periphyton scores were recorded for the Karengorengo site; prior to 2015 the heavy macrophyte cover at that site shaded out benthic algal growth.

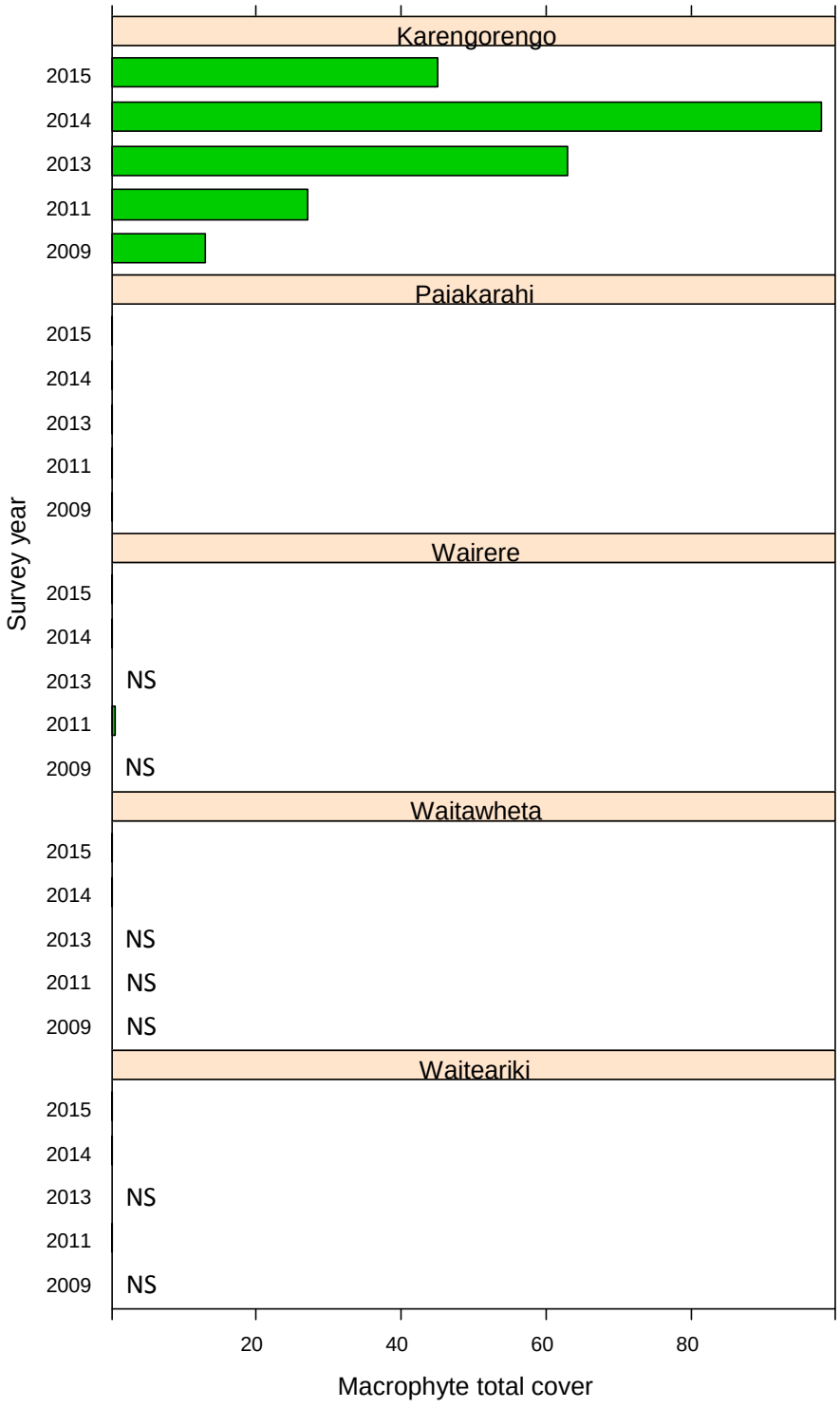

Figure 3-12: Comparison of macrophyte total cover (MTC) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

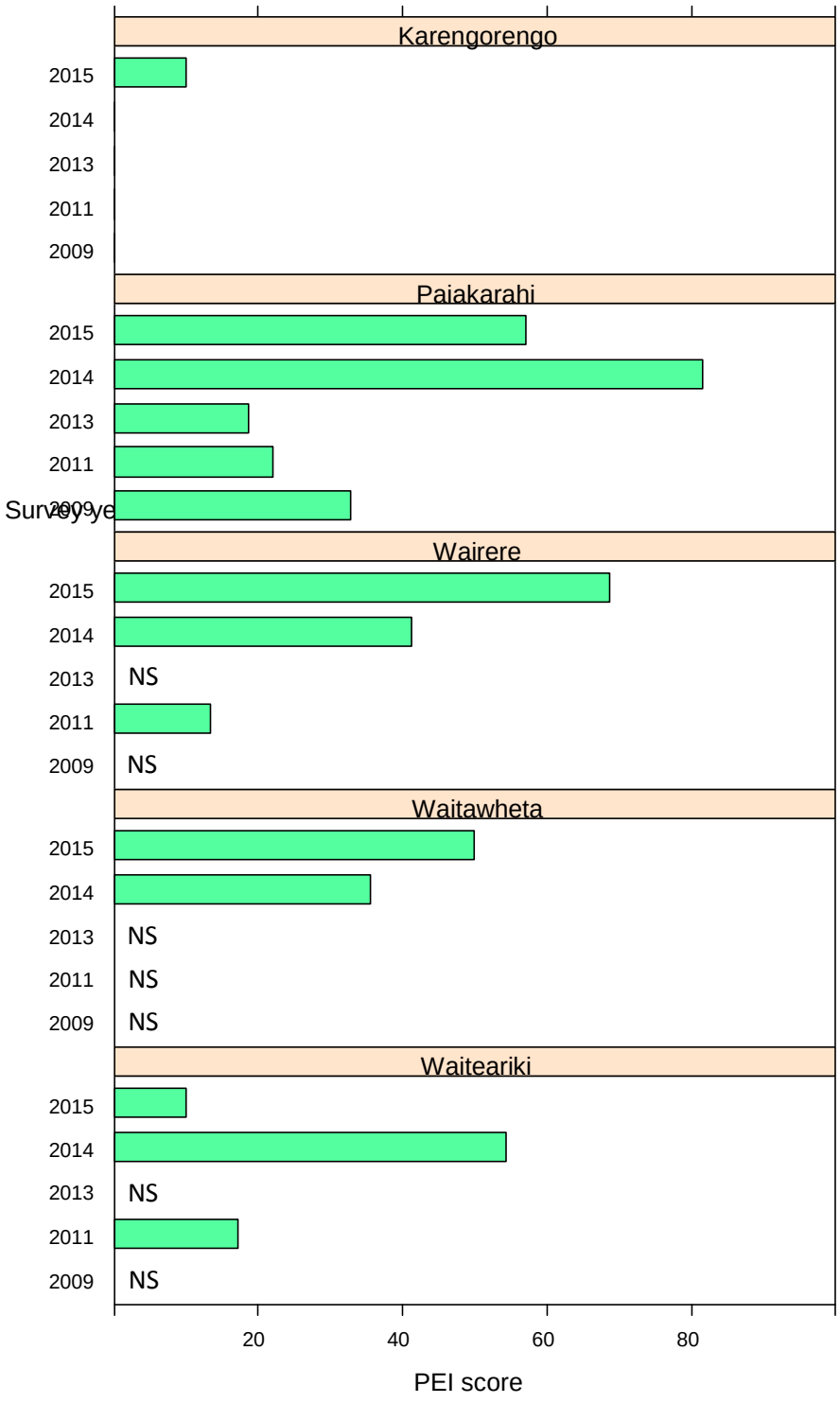

Figure 3-13: Comparison of periphyton enrichment index (PEI) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

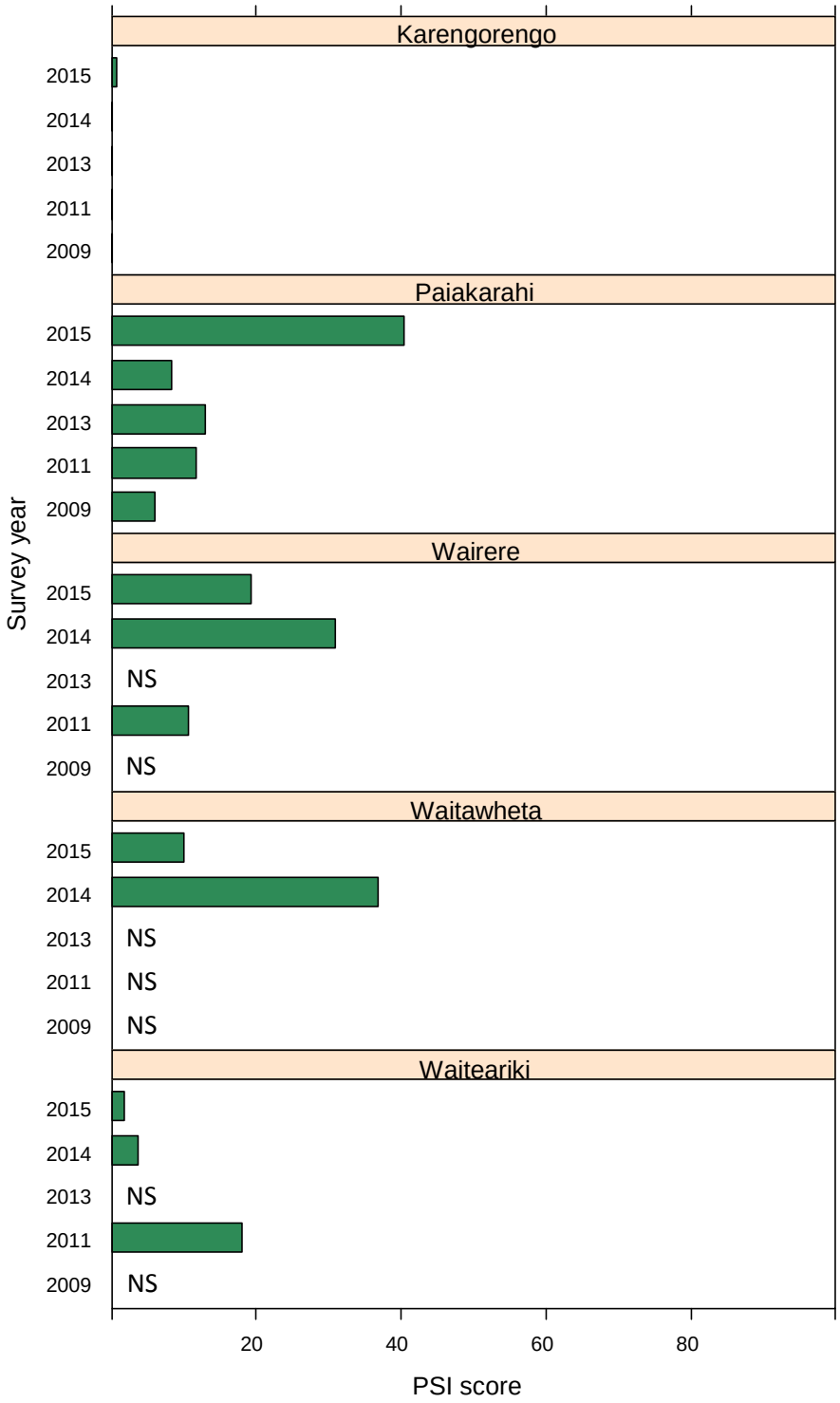

Figure 3-14: Comparison of periphyton sliminess index (PSI) scores over time at the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

3.2.4 Habitat quality scores

The habitat quality scores have remained relatively stable over time at most of the Waihou survey sites (Figure 3-15). The only site where any significant change occurred between 2014 and 2015 was the Karengorengo Stream, which declined in habitat quality. Prior to 2014 the habitat score at this site was increasing over time due to the exclusion of cattle. However, in 2015 increased stream bank erosion, notably pugging and bank slumping, was observed, resulting in reduced habitat quality. This increase in bank instability was likely associated with a decline in stream bank vegetation. Broadly speaking, the habitat score is greater in the locations where streams are less heavily modified, with a more intact riparian zone.

Correlations between habitat scores and biotic indices again indicated a positive association between the macroinvertebrate indices and habitat quality (n=18; MCI ρ=0.42; %EPT ρ=0.67) (Table 3-6 & Figure 3-16). There was also a much stronger correlation between fish species richness and habitat score at the Waihou sites (ρ=0.69), when compared to the Piako sites (Figure 3-17). This, in part, probably reflects the larger range in fish species richness in the Waihou catchment (maximum 8 species) compared to the Piako (maximum 5 species), and is indicative of a negative impact on fish species richness associated with increased channel modification.

Table 3-6: Correlation coefficients between the habitat score and various biotic indices for the Waihou catchment.

Biotic index	Spearman's rank correlation coefficient
MCI	0.44
Macroinvertebrate total richness	0.42
EPT richness	0.42
% EPT	0.67
Fish richness	0.69

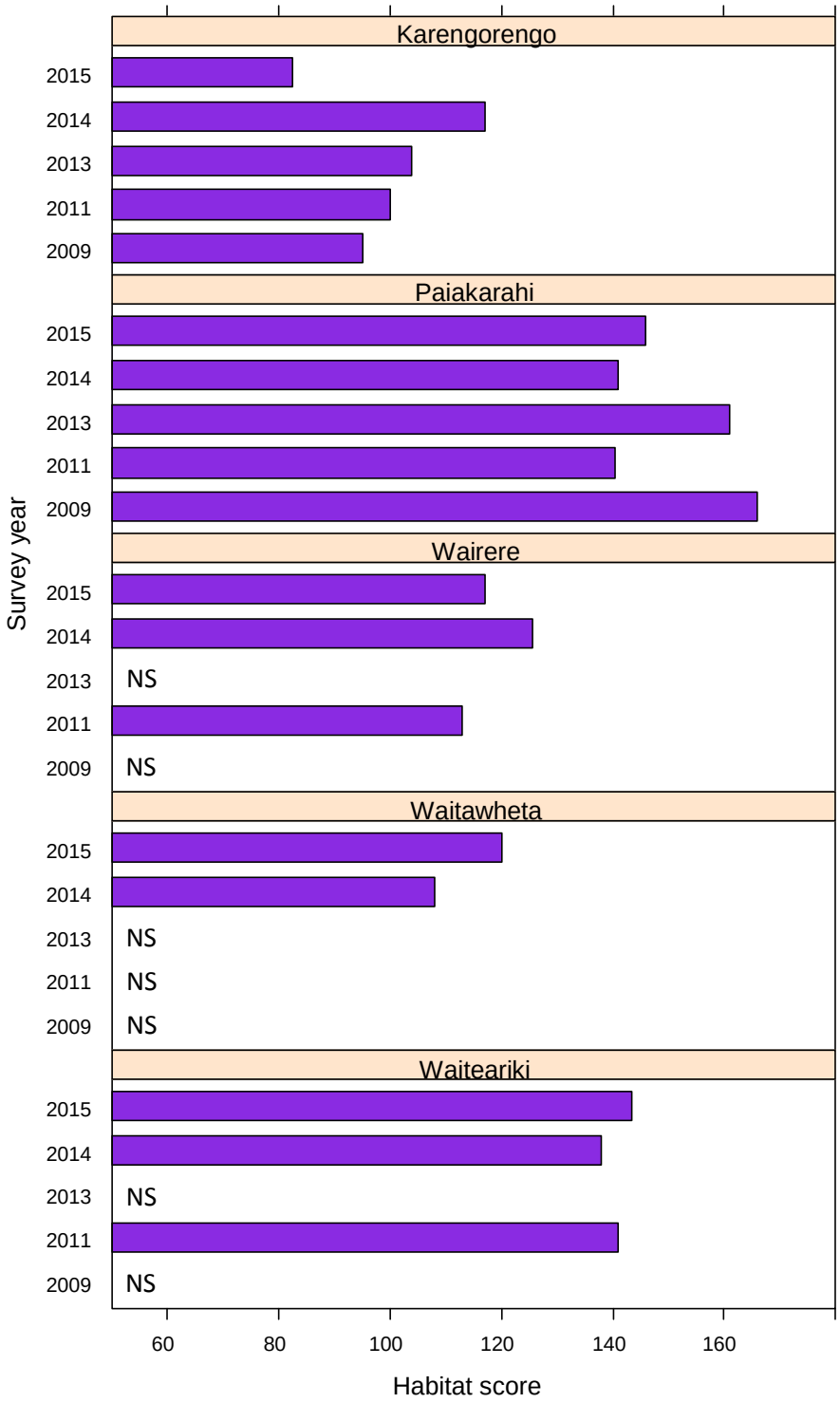

Figure 3-15: Comparison of habitat scores over time for the Waihou survey sites. Years in which a site was not surveyed are marked 'NS.'

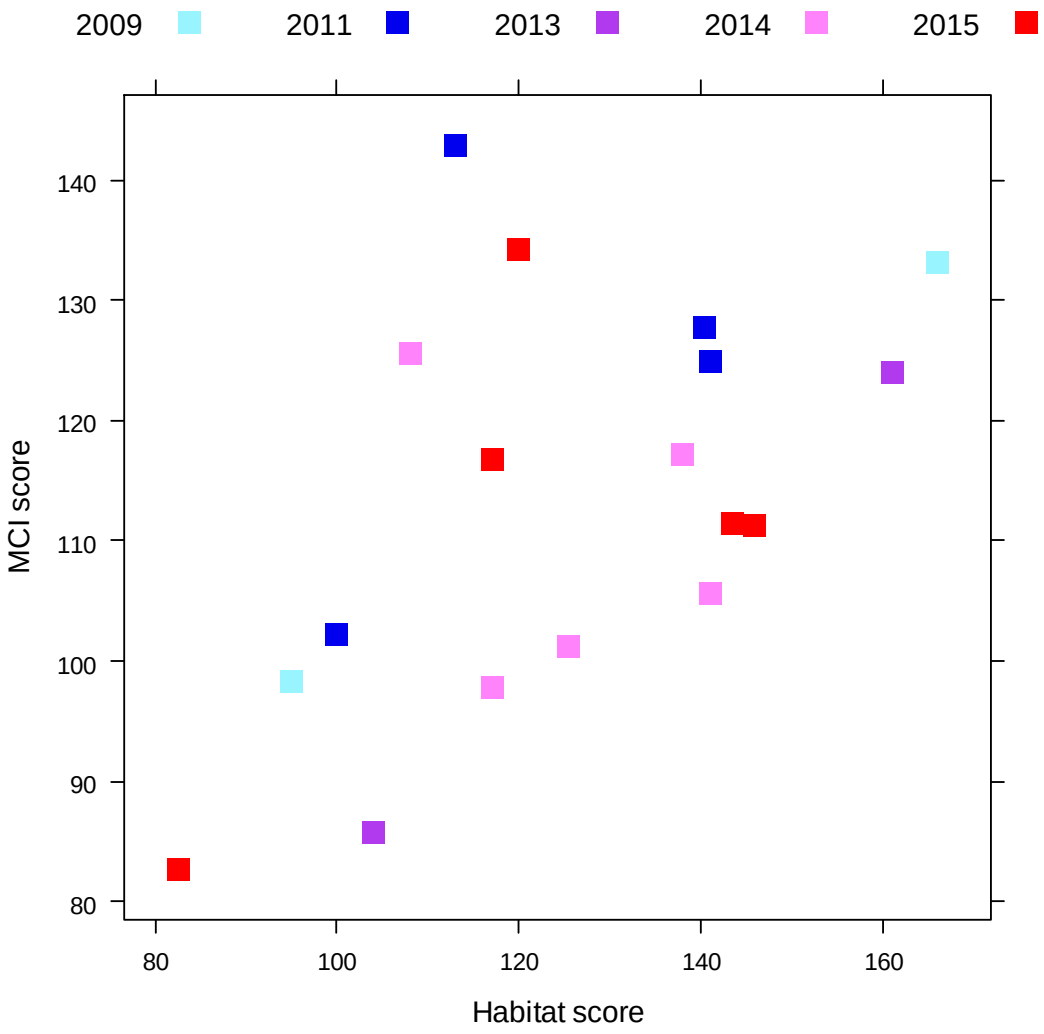

Figure 3-16: Scatterplot of habitat score against MCI score at the Waihou survey sites in different survey years (ρ=0.44).

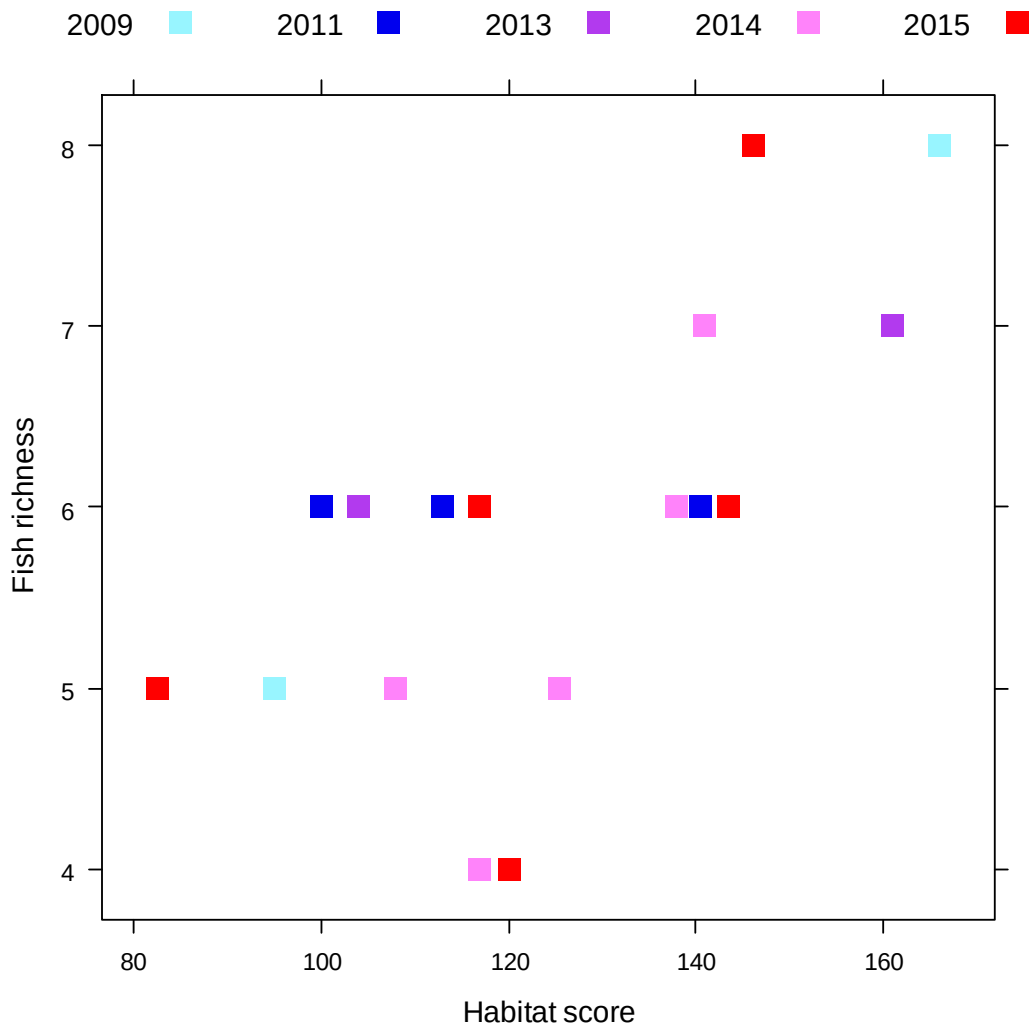

Figure 3-17: Scatterplot of habitat score against fish species richness at the Waihou survey sites in different survey years (ρ=0.69).

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 two years (2014 and 2015), 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 this survey indicate that at the Piako catchment sites, the relative abundance of fish was generally lower in 2015 than in previous survey years. Inanga continued to be absent from all five sites (compared with being present at two of the sites in 2012). Whilst the sites where they were found in 2012 (Waitoa and Mangapapa) are towards the upper extent of their likely range in the Piako, their absence is possibly indicative of the lower flows in the three successive years and hence reduced downstream connectivity. However, inanga are highly mobile and typically have low encounter probability, and thus may have been present but not captured in recent surveys.

The macroinvertebrate community scores for streams in the Piako catchment remained fairly constant at two sites (Waitakaruru and Piakonui), declined at two sites (Mangapapa and Mangakahika) and improved at one site (Waitoa). Decreased periphyton and macrophyte coverage appear to be associated with improved habitat quality and MCI scores at the Waitoa Stream site. Additionally, the fact that periphyton did not increase substantially in the absence of shading from macrophytes may suggest that eutrophication effects slowed in the Waitoa between 2014 and 2015. Further monitoring in subsequent years will be required to confirm this hypothesis. In the Mangakahika, on the other hand, it is likely that the lower MCI score is related to the decline in habitat quality at that site, which was in turn linked to bank erosion and lack of riparian vegetation, rather than high periphyton and/or macrophyte cover.

4.2 Waihou catchment

In the Waihou catchment, the numbers of fish recorded in 2015 were generally similar to those from previous surveys. A notable exception, however, is banded kokopu, which were found at three sites in 2014, but only one in 2015. However, the numbers of banded kokopu captured in 2014 were low

(one individual only in two of the three sites) and thus it is likely they were missed, rather than absent, from the same sites in 2015. Additionally, the Karengorengo site, which was largely unfishable due to very dense aquatic plant cover in 2014, was much less clogged with macrophytes in 2015 and the recorded fish abundances were similar to those reported from surveys prior to 2014. Importantly, inanga were once again captured from this site, after being absent in 2014.

Macroinvertebrate taxa richness was the highest yet recorded in four of the five Waihou catchment sites in 2015. MCI scores also improved in three of the five Waihou sites in 2015 compared to 2014, although all sites remained in the same quality class. In 2014, three of the four sites dropped a quality class; this year's survey indicates that may have been a temporary change due to low flows or changes in habitat quality, rather than a long-term trend. Interestingly, the Karengorengo score remained low (in the 'fair' category), despite significant declines in macrophyte cover. However, the Karengorengo habitat quality score was also much lower in 2015 than 2014 due to reduced riparian vegetation cover and corresponding increases in stream bank instability.

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 larger female fish captured, perhaps indicating poor growth/survival rates for this species, or high fishing pressure. The number of inanga and torrentfish captured during surveys in both catchments was also lower in most sites in 2015 than in 2014. Torrentfish have very specific habitat requirements, preferring fast flowing, turbulent habitats, and thus tend to be constrained to relatively small habitat patches within the survey reaches. Small changes in habitat structure between years can result in the loss of these habitats. These habitats are also probably more susceptible to the effects of low flows. This is likely to contribute to the observed variance in torrentfish populations which may move out of reaches during low flows in search of suitable habitats. Inanga have also generally only been found in very low numbers at the sites included in this survey; this could be due to a lack of suitable habitat or more likely distance from the coast.

5 Conclusions

Ecosystem health has been identified as a core national value that must be sustained (MfE 2013). The NPSFM 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. However, to monitor human impacts on aquatic biota it is essential to understand and be able to distinguish natural drivers of change. Establishing a long-term routine ecological monitoring network 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 even subsequent yearly samplings highlights the need for long-term monitoring to accurately characterize natural variation versus long-term trends in stream communities and stream health. Therefore, it is recommended that the same ten sites continue to be monitored annually using the same survey methods. 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 characteristics such as flow, water temperature, dissolved oxygen and water quality at the annual monitoring sites to better understand the relative importance of different environmental variables in determining the observed variations in ecology (particularly their associations with flow).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. The relative balance of the assemblage, particularly for the most numerically dominant species, should also be evaluated in future surveys to help assess changes in community composition over time.
- It would be beneficial for additional physico-chemical variables to also be collected at each of the sites, e.g., flow, 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 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 Bastiaan van Ravenhorst 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: Josh Smith	
Site number: 376_4	Sample number: 1	Date: 2/03/2015	Time: 14:30
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): 4.5 m
Stream width (water): 2.0 m
Stream depth: 0.15 m
Surface velocity: 0.20 m s^{-1}

Water quality

Temperature:	17.5	°C	Conductivity:	197.8	µS cm^{-1}
Dissolved oxygen:	70.3	%	6.72	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	-	5
Boulder	>256mm	5
Cobble	>64-256mm	75
Gravel	>2-64mm	10
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%

Habitat types sampled

(% of effort)

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

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Number of invertebrates returned:

Koura: 0	Shrimps: 0
Crabs: 0	Mussels: 0
Other: 0	
Mussel type:	

Comments:

Stream very low

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																				
Stream name: Mangakahika						Site number: 376_4														
Sample number: 1						Assessor: Josh Smith										Date: 2/03/2015				
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:10	20	19	18	17	16	15	14	13	12	11	**10**	9	8	7	6	5	4	3	2	1
Right bank:10	20	19	18	17	16	15	14	13	12	11	**10**	9	8	7	6	5	4	3	2	1
Mean: 10																				
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: 9	20	19	18	17	16	15	14	13	12	11	10	**9**	8	7	6	5	4	3	2	1
Right bank: 9	20	19	18	17	16	15	14	13	12	11	10	**9**	8	7	6	5	4	3	2	1
Mean: 9																				
3. Bank stability	• 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:10	20	19	18	17	16	15	14	13	12	11	**10**	9	8	7	6	5	4	3	2	1
Mean: 10																				
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: 12	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: 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: 12	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient					• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material					• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment					• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes				
Score:16	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
9. Periphyton	• Periphyton not evident on hand held stones • Stable substrate • Surfaces rough to touch					• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch					• Periphyton visible • <20% cover of available substrates					• Periphyton obvious & prolific • >20% cover of available substrates				
Score: 8	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 110																				

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

Stream name: Waitoa Stream		Assessor: Josh Smith	
Site number: 1249_121	Sample number: 2	Date: 5/03/2015	Time: 13:00
GPS coordinates	Downstream:	E 1831974	N 5803819
	Upstream:	E 1831878	N 5803808

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): 4.5 m
Stream width (water): 1.4 m
Stream depth: 0.15 m
Surface velocity: 0.15 m s^{-1}

Water quality

Temperature:	16.7	°C	Conductivity:	119.9	µS cm^{-1}
Dissolved oxygen:	69.2	%	6.76	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	10
Sand	>0.06-2mm	5
Silt	0.004-0.06mm	5
Clay	<0.004mm	5

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:	%		
Wood:	%	Riffles:	20%
Macrophyte:	%	Runs:	75%
Edges:	%	Pools:	5%

Number of invertebrates returned:

Koura: 10	Shrimps: 0
Crabs: 0	Mussels: 0
Other: 0	
Mussel type:	
Hyridella	*Cucumerunio*

Comments:

Low and clear

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Waitoa Stream	Site number: 1249_121	
Sample number: 2	Assessor: Josh Smith	Date: 5/03/2015

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:6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 **6**	5 4 3 2 1
Right bank:6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 **6**	5 4 3 2 1
Mean: 6				
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:7	20 19 18 17 16	15 14 13 12 11	10 9 8 **7** 6	5 4 3 2 1
Right bank:7	20 19 18 17 16	15 14 13 12 11	10 9 8 **7** 6	5 4 3 2 1
Mean: 7				
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: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: 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: 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: 13	20 19 18 17 16	15 14 **13** 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not evident on hand held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch	• Periphyton visible • <20% cover of available substrates	• Periphyton obvious & prolific • >20% cover of available substrates
Score: 10	20 19 18 17 16	15 14 13 12 11	**10** 9 8 7 6	5 4 3 2 1
TOTAL SCORE: 100				

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

Stream name: Mangapapa Stream		Assessor: Josh Smith	
Site number: 433_14	Sample number: 3	Date: 5/03/2015	Time: 9:30
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): 5.5 m
Stream width (water): 3.8 m
Stream depth: 0.15 m
Surface velocity: 0.20 m s^{-1}

Water quality

Temperature:	16.1	°C	Conductivity:	116.7	µS cm^{-1}
Dissolved oxygen:	55.8	%	5.51	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	-	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:	%		
Wood:	%	Riffles:	15%
Macrophyte:	5%	Runs:	80%
Edges:	95%	Pools:	5%

Number of invertebrates returned:

Koura: 11	Shrimps: 0
Crabs: 0	Mussels: 2 live
Other: 0	+ many shells
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: 3						Assessor: Josh Smith								Date: 5/03/2015						
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
Left bank:12	20	19	18	17	16	15	14	13	**12**	11	10	9	8	7	6	5	4	3	2	1
Right bank:7	20	19	18	17	16	15	14	13	12	11	10	9	8	**7**	6	5	4	3	2	1
Mean: 9.5																				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
Left bank:9	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: 8																				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
Left bank:13	20	19	18	17	16	15	14	**13**	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:12	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: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: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: 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: 16	20 19 18 17 **16**	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient	• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment	• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes
Score: 11	20 19 18 17 16	15 14 13 12 **11**	10 9 8 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not evident on hand held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch	• Periphyton visible • <20% cover of available substrates	• Periphyton obvious & prolific • >20% cover of available substrates
Score: 8	20 19 18 17 16	15 14 13 12 11	10 9 **8** 7 6	5 4 3 2 1
TOTAL SCORE: 116				

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

Stream name: Waitakaruru Stream		Assessor: Josh Smith	
Site number: 1231_54	Sample number: 4	Date: 2/03/2015	Time: 10:45
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): 4.0 m
Stream width (water): 2.0 m
Stream depth: 0.20 m
Surface velocity: 0.50 m s^{-1}

Water quality

Temperature:	17.6	°C	Conductivity:	136.1	µS cm^{-1}
Dissolved oxygen:	86.6	%	8.30	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	20
Gravel	>2-64mm	50
Sand	>0.06-2mm	15
Silt	0.004-0.06mm	10
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Habitat types sampled

(% of effort)

Stones:	20%		
Wood:	%	Riffles:	20%
Macrophyte:	30%	Runs:	70%
Edges:	50%	Pools:	10%

Number of invertebrates returned:

Koura: 14	Shrimps: 0
Crabs: 0	Mussels: 0
Other: 0	
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:
Fishing easier than in past years as riparian scrub has been cleared from lower sections

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Waitakaruru Stream		Site number: 1231_54
Sample number: 4	Assessor: Josh Smith	Date: 2/03/2015

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:9	20 19 18 17 16	15 14 13 12 11	10 **9** 8 7 6	5 4 3 2 1
Mean: 9				
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: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: 7	20 19 18 17 16	15 14 13 12 11	10 9 8 **7** 6	5 4 3 2 1
5. Channel alteration	• Changes to channel/dredging absent/minimal • Stream with normal pattern	• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present	• Channel changes/dredging extensive • Embankments/shoring structures present on both banks • 40-80% of reach Channelized & disrupted	• Banks shored with gabion/cement • >80% of stream reach channelized or disrupted • Instream habitat altered/absent
Score: 15	20 19 18 17 16	**15** 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat parameter	Category Optimal					Habitat parameter					Category Optimal					Habitat parameter				
6. Sediment deposition	• Little/no islands or point bars present • <20% of bottom affected by sediment deposition					• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of bottom affected • Slight deposition in pools					• Some deposition of new gravel, sand or fine sediment on old & new bars • 50-80% of bottom affected • Sediment deposits at obstructions, constrictions & bends					• Heavy deposits of fine material • Increased bar development • >80% of bottom changing frequently • Pools almost absent due to sediment deposition				
Score: 10	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: 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: 5	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 87																				

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

Stream name: Piakonui Stream		Assessor: Josh Smith	
Site number: 753_15	Sample number: 5	Date: 4/03/2015	Time: 15:30
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): 3.5 m
Stream width (water): 2.0 m
Stream depth: 0.15 m
Surface velocity: 0.20 m s^{-1}

Water quality

Temperature:	13.1	°C	Conductivity:	90.1	µS cm^{-1}
Dissolved oxygen:	82.7	%	8.69	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	60
Gravel	>2-64mm	10
Sand	>0.06-2mm	15
Silt	0.004-0.06mm	10
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Habitat types sampled

(% of effort)

Stones:	50%		
Wood:	10%	Riffles:	30%
Macrophyte:	%	Runs:	60%
Edges:	40%	Pools:	10%

Number of invertebrates returned:

Koura: 83	Shrimps: 0
Crabs: 0	Mussels: 0
Other: 0	
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: Piakonui Stream						Site number: 753_15														
Sample number: 5						Assessor: Josh Smith									Date: 4/03/2015					
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:15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 17.5																				
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:20	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:15	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 17.5																				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
Left bank:16	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:16	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean: 16																				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key					• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15					• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25					• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25				
Score: 19	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: 19	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: 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: 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: 18	20	19	**18**	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 151																				

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

Stream name: Paiakarahi Stream		Assessor: Josh Smith	
Site number: 718_5	Sample number: 6	Date: 6/03/2015	Time: 11:00
GPS coordinates	Downstream:	E 1841027	N 5867879
	Upstream:	E 1841098	N 5867799

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): 6.5 m
Stream width (water): 3.5 m
Stream depth: 0.25 m
Surface velocity: 0.15 m s^{-1}

Water quality

Temperature:	16.4	°C	Conductivity:	118.7	µS cm^{-1}
Dissolved oxygen:	58.2	%	5.71	mg l^{-1}	

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

Stream-bottom substrata

Compaction (inorganic substrata):

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

Embeddedness:
(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	15
Cobble	>64-256mm	71
Gravel	>2-64mm	10
Sand	>0.06-2mm	2
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:	70%		
Wood:	%	Riffles:	20 %
Macrophyte:	%	Runs:	65%
Edges:	30%	Pools:	15%

Number of invertebrates returned:

Koura: 34	Shrimps: 3
Crabs: 0	Mussels: 0
Other:	
Mussel type:	
Hyridella	*Cucumerunio*

Comments:

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Paiakarahi Stream	Site number: 718_5	
Sample number: 6	Assessor: Josh Smith	Date: 6/03/2015

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:19	20 **19** 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean: 18.5				
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:19	20 **19** 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean: 18.5				
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: 15	20 19 18 17 16	**15** 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right bank:15	20 19 18 17 16	**15** 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean: 15				
4. Frequency of riffles	• Riffles relatively frequent • Distance between riffles divided by stream width=5-7 • Variety of habitat is key	• Occurrence of riffles infrequent • Distance between riffles divided by stream width=7-15	• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by stream width=15-25	• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by stream width=>25
Score: 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: 19	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: 19	20 **19** 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance & diversity of habitat	• >50% substrate favourable for invertebrate colonisation & wide variety of woody debris, riffles, root mats • Snags/ submerged logs/undercut banks/cobbles provides abundant fish cover • Must not be new or transient	• 30-50% substrate favourable for invertebrate colonisation • Snags/ submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment	• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes
Score: 18	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not evident on hand held substrates (macrophytes, wood etc.,) or fine sediments	• Periphyton not visible on substrates but obvious to touch	• Periphyton visible • <20% cover of available substrates	• Periphyton obvious & prolific • >20% cover of available substrates
Score: 4	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 **4** 3 2 1
TOTAL SCORE:146				

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

Stream name: Karengorengo Stream		Assessor: Josh Smith	
Site number: 232_3	Sample number: 7	Date: 3/03/2015	Time: 13:40
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): 5.0 m
Stream width (water): 2.0 m
Stream depth: 0.50 m
Surface velocity: 0.60 m s^{-1}

Water quality

Temperature:	15.6	°C	Conductivity:	146.0	µS cm^{-1}
Dissolved oxygen:	70.0	%	7.03	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	
Sand	>0.06-2mm	90
Silt	0.004-0.06mm	10
Clay	<0.004mm	

Organic material (% cover)

Large wood (>10cm diameter)

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

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

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

Fine (<1mm) organic deposits

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

Habitat types sampled

(% of effort)

Stones:	%		
Wood:	%	Riffles:	%
Macrophyte:	50%	Runs:	100%
Edges:	50%	Pools:	%

Number of invertebrates returned:

Koura: 31	Shrimps: 0
Crabs: 0	Mussels: 0
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:

Low and clear, less macrophytes than last year

Wadeable Soft-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																					
Stream name: Karengorengo Stream								Site number: 232_3													
Sample number: 7						Assessor: Josh Smith									Date: 3/03/2015						
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor					
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious					
Left bank:7	20	19	18	17	16	15	14	13	12	11	10	9	8	**7**	6	5	4	3	2	1	
Right bank:6	20	19	18	17	16	15	14	13	12	11	10	9	8	7	**6**	5	4	3	2	1	
Mean: 6.5																					
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: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: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																					
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: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:9	20	19	18	17	16	15	14	13	12	11	10	**9**	8	7	6	5	4	3	2	1
7. Pool variability	• Pools evenly mixed • Large/shallow, large/deep, small/shallow, small/deep					• Majority of pools large/deep • Very few shallow pools					• Prevalence of shallow pools					• Majority of pools small/shallow				
Score: 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: 6	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: 16	20	19	18	17	**16**	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE: 82.5																				

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: 3/03/2015	Time: 9:30
GPS coordinates	Downstream:	E 1851649	N 5819801
	Upstream:	E 1851719	N 5819721

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): 8.5 m
Stream width (water): 5.0 m
Stream depth: 0.35 m
Surface velocity: 0.10 m s^{-1}

Water quality

Temperature:	15.5	°C	Conductivity:	66.5	µS cm^{-1}
Dissolved oxygen:	69.2	%	6.91	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	-	2
Boulder	>256mm	10
Cobble	>64-256mm	5
Gravel	>2-64mm	15
Sand	>0.06-2mm	20
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%

Habitat types sampled

(% of effort)

Stones:	60%		
Wood:	%	Riffles:	10%
Macrophyte:	%	Runs:	30%
Edges:	40%	Pools:	60%

Number of invertebrates returned:

Koura: 15	Shrimps: 6
Crabs: 0	Mussels: 0
Other: 0	
Mussel type:	
Hyridella	*Cucumerunio*

Instream plant cover (% streambed area)

Filamentous algae & mats:

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

Macrophytes:

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

Mosses/liverworts:

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

Wadeable Hard-Bottomed Streams Qualitative Habitat Assessment Field Data Sheet																				
Stream name: Wairere stream								Site number: 1224_5												
Sample number: 8						Assessor: Josh Smith								Date: 3/03/2015						
Habitat parameter	Category Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
Left bank:16	20	19	18	17	**16**	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:12	20	19	18	17	16	15	14	13	**12**	11	10	9	8	7	6	5	4	3	2	1
Mean: 14																				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
Left bank:10	20	19	18	17	16	15	14	13	12	11	**10**	9	8	7	6	5	4	3	2	1
Right bank:7	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:16	20	19	18	17	**16**	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:11	20	19	18	17	16	15	14	13	12	**11**	10	9	8	7	6	5	4	3	2	1
Mean: 13.5																				
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: 9	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: 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: 16	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: 9	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TOTAL SCORE 117																				

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: 4/03/2015	Time: 10:00
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 m
Stream width (water): 6 m
Stream depth: 0.30 m
Surface velocity: 0.25 m s^{-1}

Water quality

Temperature:	14.6	°C	Conductivity:	93.2	µS cm^{-1}
Dissolved oxygen:	85.5	%	8.66	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	30
Cobble	>64-256mm	60
Gravel	>2-64mm	7
Sand	>0.06-2mm	2
Silt	0.004-0.06mm	1
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:	70%		
Wood:	%	Riffles:	75%
Macrophyte:	%	Runs:	20%
Edges:	30%	Pools:	5%

Number of invertebrates returned:

Koura: 125	Shrimps: 0
Crabs: 0	Mussels: 0
Other: 0	
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:

Very low

Wadeable Hard-Bottomed Streams
Qualitative Habitat Assessment Field Data Sheet

Stream name: Waiteariki Stream		Site number: 1430_10
Sample number: 9	Assessor: Josh Smith	Date: 4/03/2015

Habitat parameter	Category																			
	Optimal					Suboptimal					Marginal					Poor				
1. Riparian vegetative zone width	• Bankside vegetation buffer >10m • Continuous & dense					• Bankside vegetation buffer is <10m • Mostly continuous					• Pathways present and/or stock • Mostly healed over					• Breaks frequent • Human activity obvious				
Left bank:16	20	19	18	17	**16**	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:11	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:18	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: 14																				
3. Bank stability	• Banks stable • Erosion/bank failure absent/minimal • <5% of bank affected					• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded					• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods					• Unstable • Many eroded areas • 60-100% of bank has erosional scars				
Left bank:16	20	19	18	17	**16**	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank:12	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: 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: 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: 143.5																				

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

Stream name: Waitawheta River		Assessor: Josh Smith	
Site number: 1235_11	Sample number: 10	Date: 6/03/2015	Time: 15:30
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): 6.0 m
Stream width (water): 2.5 m
Stream depth: 0.10 m
Surface velocity: 0.15 m s^{-1}

Water quality

Temperature:	15.1	°C	Conductivity:	104.1	µS cm^{-1}
Dissolved oxygen:	58.2	%	5.87	mg l^{-1}	

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

Stream-bottom substrata

Compaction (inorganic substrata):

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

Embeddedness:
(% gravel-boulder particles covered by fine sediment)

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

% surficial inorganic substratum size composition:

Substratum	Dimension	Percentage
Bedrock	-	
Boulder	>256mm	10
Cobble	>64-256mm	72
Gravel	>2-64mm	15
Sand	>0.06-2mm	2
Silt	0.004-0.06mm	1
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:	70%		
Wood:	%	Riffles:	20%
Macrophyte:	%	Runs:	75%
Edges:	30%	Pools:	5%

Number of invertebrates returned:

Koura: 25	Shrimps: 0
Crabs: 0	Mussels: 0
Other: 0	
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: Josh Smith										Date: 6/03/2015				
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:10	20	19	18	17	16	15	14	13	12	11	**10**	9	8	7	6	5	4	3	2	1
Mean: 7																				
2. Vegetative protection	• Bank surfaces & immediate riparian zones covered by native vegetation • Trees, under-storey shrubs or non-woody plants present • Vegetative disruption minimal					• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry					• Bank surfaces covered by mixture of grasses/shrubs, blackberry, willow & introduced species • Vegetation disruption obvious • Bare soil/closely cropped vegetation common					• Bank surfaces covered by grasses & shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to bank				
Left bank: 3	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: 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:16	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: 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: 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 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: 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: 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: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: 7	20	19	18	17	16	15	14	13	12	11	10	9	8	**7**	6	5	4	3	2	1
TOTAL SCORE: 120																				

Appendix B Fish surveys

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Mike Martin (NIWA), Elizabeth Graham (NIWA), Kathryn Reeve (NIWA)			GPS (d/s):	E1818698	N5838814	Site:	Mangakahika Stream					Date:	02/03/2015								
			GPS (u/s):	E1818618	N5838767	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):	35	Fishing time:	Start 14:30 Finish 16:30	Sample distance (m):	150	Wetted width (m):	A	0.8	C	2.5	E	1.2	G	2.0	I	1.5			
									B	2.0	D	1.9	F	1.1	H	1.7	J				
Sampling gear:	Spotlight	EFM	Seine	Length (m) / Mesh (mm)		Water visibility:	Good	Average	Poor	Water temp. (°C):	17.5	Conductivity (µS):	197.8								
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 A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common bully	1		1		4		1				7		21	59	
Banded kokopu	1		6	1	11	1		6	2	2	30		48	174	
Shortfin eel		1	2	2	1	1	2	3	3	3	18		125	422	
Longfin eel										1	1		795	795	
Elver	1		1			1					3		100	100	
Unidentified eel					2				1		3		175	200	

FLAG	Comment	FLAG	Comment
	Water very low		

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Mike Martin (NIWA), Elizabeth Graham (NIWA), Bastiaan Van Ravenhorst (NIWA)	GPS (d/s): E1831974 N5803819 GPS (u/s): E1831878 N5803808	Site: Waitoa Stream	Date: 05/03/2015

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): 74	Fishing time: Start 13:00, Finish 15:00	Sample distance (m): 150	Wetted width (m): A 0.9, B 1.2, C 1.7, D 0.8, E 1.0, F 1.5, G 2.1, H 1.8, I 1.9, J

Sampling gear: Spotlight, **EFM**, Seine, Length (m) / Mesh (mm)	Water visibility: **Good**, Average, Poor	Water temp. (°C): 16.7	Conductivity (µS): 119.9		
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	8	6	16	4	2	9		14	8		67		20	78	
Shortfin eel	7	23	11	8	6	4		11	10		80		95	450	
Elver	2	3	5		5	4		1	2		22		75	250	
Koura	0	2	1	1				2	4		10				

FLAG	Comment	FLAG	Comment
	Small anode used for pocket water in sections A and B, other sub-reaches used big anode		
	Zero paratya		
G	Subreach G missed due to 100% watercress		
J	Subreach J also missed due to 90% watercress cover		

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Mike Martin (NIWA), Elizabeth Graham (NIWA), Bastiaan Van Ravenhorst (NIWA)	GPS (d/s): E1836783 N5809932 GPS (u/s): E1836750 N5809802	Site: Mangapapa Stream	Date: 05/03/2015

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):	76	Fishing time:	Start 09:00 Finish 12:00	Sample distance (m):	150

Wetted width (m):									
A	2.2	C	2.9	E	4.2	G	4.6	I	3.1
B	4.4	D	3.7	F	4.1	H	3.8	J	

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C):	16.1	Conductivity (µS):	116.7

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	12	7	18	11	12	22	9	12	1		104		20	68	
Shortfin eel	1		6	3	3	5	11	2	3	2	36		84	650	
Longfin eel	1	1	2			1					5		101	700	
Elver		1		2	2	1			1		7		100	150	
Unidentified eel	1										1				
Koura	1	2	2	1	1	2	1		1		11				

FLAG	Comment	FLAG	Comment
	Water low and clear		
	Lots of Hyridella shells found		
	2 live mussels found in reach H		

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Mike Martin (NIWA), Elizabeth Graham (NIWA), Kathryn Reeve (NIWA)	GPS (d/s): E1817745 N5815748 GPS (u/s): E1817903 N5815670	Site: Waitakaruru Stream				Date: 02/03/2015
		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): 43	Fishing time: Start 10:45 Finish 12:40	Sample distance (m): 150	Wetted width (m):	A	C	E	G	I
					B	D	F	H	J

Sampling gear:	Spotlight	EFM	Seine	Length (m) / Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C): 17.6	Conductivity (µS): 136.1
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	3			3	11	11	12	11	5	7	63		18	55	
Shortfin eel	4	2	3	3	1	2	4	3	5	3	30		87	718	
Elver			1				1	2			4		100	100	
Unidentified eel		1	1	1				1			4		200	450	
Torrentfish	2				1						3		83	128	
Koura				4			4	2	3	1	14				

FLAG	Comment	FLAG	Comment
	Less in-stream scrub – making fishing faster		

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Mike Martin (NIWA), Elizabeth Graham (NIWA), Bastiaan Van Ravenhorst (NIWA)	GPS (d/s): E1831211 N5815768 GPS (u/s): E1831210 N5809980	Site: Piakonui Stream			Date: 04/03/2015

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): 52	Fishing time: Start 15:30 Finish 18:15	Sample distance (m): 150	Wetted width (m):	A	1.9	C	2.1	E	1.9	G	1.4	I	1.9
					B	2.7	D	2.1	F	2.1	H	1.6	J	3.2

Sampling gear: Spotlight	EFM	Seine	Length (m) / Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C): 13.1	Conductivity (µS): 90.1										
EFM anode: Big / Small	EFM volts (x100): 3	EFM pulse rate (Hz or pps): 60	EFM pulse width (ms): 2	Spotlight (watts):															

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common bully			1	3	1				6	10	21		30	79	
Banded kokopu	2	2								1	5		55	172	
Shortfin eel	2	1	2			1	3	1	2	1	13		97	163	
Longfin eel				1	1	1		1			4		438	640	
Elver		1		1		1				3	6		100	100	
Koura	12	7	4	16	8	11	11	7	7		83				

FLAG	Comment	FLAG	Comment
	Low and clear		
	High sediment load		

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Kathryn Reeve (NIWA) Elizabeth Graham (NIWA), Bastiaan Van Ravenhorst (NIWA)	GPS (d/s): E1841027 N5867879 GPS (u/s): E1841098 N5867799	Site: Paiakarahi Stream				Date: 06/03/2015
		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): 48	Fishing time: Start 11:00 Finish 13:10	Sample distance (m): 150	Wetted width (m):	A	2.2	C	3.7	E	4.4	G	2.6	I	2.1
					B	2.8	D	4.2	F	3.2	H	2.4	J	2.4

Sampling gear:	Spotlight	EFM	Seine	Length (m) / Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C): 16.4	Conductivity (µS): 118.7
EFM anode: Big / Small	EFM volts (x100): 4	EFM pulse rate (Hz or pps): 60	EFM pulse width (ms): 2	Spotlight (watts):

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Banded kokopu			1								1		51	51	
Shortfin eel	1		2			1		2			6		108	170	
Longfin eel		1	1		3	2		2		1	10		162	650	
Unidentified eel		1				1	1	1			4		100	200	
Cran's bully	3	2	7	4	6	1	2	6	2		33		20	75	
Torrentfish										1	1		114	114	
Inanga							2				2		85	85	
Brown trout					1				1		2		260	280	
Rainbow trout										2	2		105	120	
Koura			3	6	12	7	2	2	2		34				
Paratya								3			3				

FLAG	Comment	FLAG	Comment

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Kathryn Reeve (NIWA), Elizabeth Graham (NIWA), Bastiaan Van Ravenhorst (NIWA)	GPS (d/s): E1848393 N5823235 GPS (u/s): E1848423 N5823089	Site: Karengorengo Stream			Date: 03/03/2015
		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):	Fishing time:	Start 13:40 Finish 17:00	Sample distance (m): 150	Wetted width (m):	A	1.7	C	1.8	E	1.9	G	3.1	I	2.9
						B	1.7	D	2.3	F	2.2	H	2.8	J	

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C):	15.6	Conductivity (µS):	146.1							

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										Total count	Sample count	Length (mm)		FLAG
	A	B	C	D	E	F	G	H	I	J			Min.	Max.	
Common bully	2			1	2	3	4	2	1	2	17		30	74	
Shortfin eel	15	10	10	12	3	14	7	9	11	7	98		75	675	
Inanga							1				1		93	93	
Smelt	9	1			12		2				24		57	93	
Trout (unidentified)			1	1						2	4		40	150	
Koura	4	5	6	1	3	4	6	1	1		31				

FLAG	Comment	FLAG	Comment
	Water level low – less macrophytes than last year		
	Some deeper and weed-covered sections missed		

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Kathryn Reeve (NIWA), Elizabeth Graham (NIWA), Bastiaan Van Ravenhorst (NIWA)	GPS (d/s): E1851649 N5819801 GPS (u/s): E1851719 N5803808	Site: Wairere Stream				Date: 03/03/2015
		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): 92	Fishing time: Start 09:30 Finish 13:15	Sample distance (m): 150	Wetted width (m):	A	6.1	C	5.8	E	4.3	G	7.2	I	5.1
					B	6.8	D	6.2	F	4.8	H	4.7	J	5.3

Sampling gear:	Spotlight	EFM	Seine	Length (m) / Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C): 15.5		Conductivity (µS): 66.5	
EFM anode: Big / Small	EFM volts (x100): 4	EFM pulse rate (Hz or pps): 60	EFM pulse width (ms): 2	Spotlight (watts):								

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common bully	12	18	24	12	18	29	40	15	7	33	208		21	68	
Shortfin eel	30	6	13	9	10	11	28	23	7	11	148		86	530	
Longfin eel				1							1		930	930	
Elver	1		4	8			9	3	3	6	34				
Unidentified eel		6			2	2			1	3	14		150	350	
Torrentfish										2	2		80	93	
Rainbow trout					1					2	3		80	108	
Brown trout		1			1		2			1	5		95	350	
Koura	3	2	3	2	2		1	1		1	15				
Paratya	1	1	3			1					6				

FLAG	Comment	FLAG	Comment

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Mike Martin (NIWA), Elizabeth Graham (NIWA), Bastiaan Van Ravenhorst (NIWA)	GPS (d/s): E1852566 N5818150 GPS (u/s): E1852697 N5818212	Site: Waiteariki Stream				Date: 04/03/2015
		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): 89	Fishing time: Start 09:45 Finish 14:17	Sample distance (m): 150	Wetted width (m):	A	4.4	C	6.4	E	4.5	G	8.8	I	5.7
					B	5.6	D	6.1	F	4.9	H	9.1	J	6.2

Sampling gear: Spotlight	EFM	Seine	Length (m) / Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C): 14.5	Conductivity (µS): 88.3
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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										Total count	Sample count	Length (mm)		FLAG
	A	B	C	D	E	F	G	H	I	J			Min.	Max.	
Shortfin eel	10	16	2	8	7		2	4		2	51		95	430	
Longfin eel	1				1	3	2	2	6		15		150	850	
Cran's bully	5	11	5	9	12	13	4	5		23	87		20	75	
Rainbow trout							1				1		120	120	
Brown trout							1				1		400	400	
Torrentfish							2				2		81	116	
Koura	18	17	2	7	13	7	8	26	20	7	125				

FLAG	Comment	FLAG	Comment
	Stream low and clear		
	Subreach A-D Elizabeth fishing, subreach E-J Josh fishing		
	Sections G and H water disappearing under rocks – fish habitat minimal		

Fish collection form – Wadeable streams/rivers

Team members: Josh Smith (NIWA), Kathryn Reeve (NIWA), Elizabeth Graham (NIWA), Bastiaan Van Ravenhorst (NIWA)	GPS (d/s): E1845480 N5849662 GPS (u/s): E1845388 N5849622	Site: Waitawheta River			Date: 06/03/2015

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):	49	Fishing time:	Start 15:00 Finish 17:00	Sample distance (m):	150	Wetted width (m):	A	2.8	C	3.3	E	1.7	G	3.2	I	2.6
									B	3.1	D	2.2	F	2.3	H	4.0	J	2.8

Sampling gear:	Spotlight	EFM	Seine	Length (m) Mesh (mm)	Water visibility:	Good	Average	Poor	Water temp. (°C):	15.1	Conductivity (µS):	104.1							

EFM anode: Big / Small	EFM volts (x100): 4	EFM pulse rate (Hz or pps): 60	EFM pulse width (ms): 2	Spotlight (watts):	

Species	Sub-reach tally A	B	C	D	E	F	G	H	I	J	Total count	Sample count	Length (mm) Min.	Max.	FLAG
Common bully	4		9	13	6	3	5	6	4	3		53	30	80	
Shortfin eel			4	2			4	1	1			12	132	351	
Longfin eel	3		2	1	3		2	1	3	2		17	205	710	
Unidentified eel			1	2	1			2	2			8	100	200	
Brown trout					1							1	160	160	
Koura	2	2	3	6	2	1	5	1	2	1		25			

FLAG	Comment	FLAG	Comment

Appendix C Macrophytes and periphyton

Periphyton Assessment							
Stream: Mangakahika Stream		Date: 02/03/2015					
Sample Number: 1		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	20	20	20	20	20	20
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)						0
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet											
Stream: Mangakahika Stream			**Located number**:				**Sample Number**: 1			**Date**: 02/03/2015	
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	2.0	4.5	0	0					0		
2	2.5	4.5	0	0					0		
3	1.9	5.0	0	0					0		
4	1.2	6.0	0	0					0		
5	1.0	5.0	0	0					0		

Periphyton Assessment							
Stream: Waitoa Stream		Date: 05/03/2015					
Sample Number: 2		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	5	5	5	0	5	4
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)						0
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet										
Stream: Waitoa Stream			**Located number**:			**Sample Number**: 2			**Date**: 05/03/2015	
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	1.0	4.5	20	0					20	Gr (5) Na (15)
2	1.3	4.5	5	0					5	Gr
3	0.8	3.0	2	0					2	Gr
4	1.4	4.0	100	0					100	Na
5	1.1	4.0	20	0					20	Na

Periphyton Assessment							
Stream: Mangapapa Stream		Date: 05/03/2015					
Sample Number: 3		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	10	5	5	5	5	6
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)				15	5	4
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)			5	5	10	4
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet											
Stream: Mangapapa Stream			**Located number**:				**Sample Number**: 3			**Date**: 05/03/2015	
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	4.1	4.8	0	0						0	
2	2.9	4.7	9	5			5	Ec (3) Nh (2)		4	Lp (3) Le (1)
3	3.2	4.5	5	0						5	Gr
4	3.9	4.5	6	0						6	Gr (3) Le (3)
5	3.0	4.5	2	0						2	Gr

Periphyton Assessment							
Stream: Waitakaruru Stream		Date: 02/03/2015					
Sample Number: 4		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	20	10	10	10	10	12
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)						0
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)			10	30	35	15
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet										
Stream: Waitakaruru Stream			**Located number**:				**Sample Number**: 4		**Date**: 02/03/2015	
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	3.1	4.5	40	30	30	Lm (10) Pk (20)			10	Ph
2	2.9	4.5	90	80	80	Lm (10) Pk (70)			10	Ph
3	3.1	5.0	10	10	10	Lm			0	
4	2.5	4.0	20	20	20	Lm (5) Pk (15)			0	
5	3.5	4.5	50	50	50	Lm (10) Pk (40)			0	

Periphyton Assessment							
Stream: Piakonui Stream		Date: 04/03/2015					
Sample Number: 5		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA						0
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)						0
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet											
Stream: Piakonui Stream			**Located number**:				**Sample Number**: 5			**Date**: 04/03/2015	
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	2.7	3.5	0	0					0		
2	2.2	3.5	0	0					0		
3	1.9	3.5	0	0					0		
4	1.8	3.5	0	0					0		
5	2.1	3.7	0	0					0		

Periphyton Assessment							
Stream: Paiakarahi Stream		Date: 06/03/2015					
Sample Number: 6		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	70	70	5		5	30
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)						0
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)		5	80	70	60	43
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet											
Stream: Paiakarahi Stream			**Located number**:				**Sample Number**: 6			**Date**: 06/03/2015	
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	3.8	6.5	0	0					0	0	
2	2.6	6.0	0	0					0	0	
3	3.9	6.5	0	0					0	0	
4	4.0	7.0	0	0					0	0	
5	3.8	7.0	0	0					0	0	

Periphyton Assessment							
Stream: Karengorengo Stream		Date: 03/03/2015					
Sample Number: 7		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	10			10		4
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)						0
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet											
Stream: Karengorengo Stream			**Located number**:				**Sample Number**: 7		**Date**: 03/03/2015		
Transect	Wetted width (m)	Channel width (m)	Vegetation cover (% wetted area)								
			Total cover	Submerged plants					Emergent plants		
				Total submerged	Surface-reaching		Below surface		Total emergent	Species
					Sub-total	Species	Sub-total	Species		
1	1.9	5	50	5			5	Nh	45	An (30) Ph (15)
2	2.1	5.2	50	0					50	An (45) Ph (5)
3	2.3	5.5	25	0					25	An (10) Gr (5) Ph (10)
4	2.1	5.5	55	0					55	An (40) Ph (15)
5	1.8	5.0	45	5			5	Nh	40	An (30) Ph (10)

Periphyton Assessment							
Stream: Wairere Stream		Date: 03/03/2015					
Sample Number: 8		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	5	5	15	5	10	8
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)						0
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)	20	35	5	30	20	22
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet											
Stream: Wairere Stream			**Located number**:			**Sample Number**: 8			**Date**: 03/03/2015		
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	6.8	9.0	0	0					0	
2	5.8	8.5	0	0					0	
3	4.3	7.5	0	0					0	
4	6.2	7.5	0	0					0	
5	6.5	8.5	0	0					0	

Periphyton Assessment							
Stream: Waitearikiki Stream		Date: 04/03/2015					
Sample Number: 9		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	10	5	10	10	10	9
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)						0
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet											
Stream: Waiteariki Stream			**Located number**:				**Sample Number**: 9			**Date**: 04/03/2015	
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	5.5	8.0	0	0					0	
2	5.8	8.5	0	0					0	
3	6.1	8.5	0	0					0	
4	6.6	8.5	0	0					0	
5	6.4	9.0	0	0					0	

Periphyton Assessment							
Stream: Waitawheta River		Date: 06/03/2015					
Sample Number: 10		Located number:					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin (<0.5mm) Mat/Film	NA	10	10	10	10	10	10
Medium mat/film (0.5-3mm thick)	Green (% cover)						0
	Light brown (% cover)						0
	Black/dark brown (% cover)						0
Thick (>3mm) mat/film	Green/light brown (% cover)						0
	Black/dark brown (% cover)						0
Filaments short (<2cm)	Green (% cover)						0
	Brown/Reddish (% cover)						0
Filaments long (>2cm)	Green (% cover)	40	5			5	10
	Brown/Reddish (% cover)						0
Submerged bryophytes	NA						0
Iron Bacteria growths	NA						0

Macrophyte recording sheet											
Stream: Waitawheta River			**Located number**:				**Sample Number**: 10			**Date**: 06/03/2015	
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	3.1	6.5	0	0					0	
2	2.9	6.5	0	0					0	
3	1.8	7.0	0	0					0	
4	3.2	7.0	0	0					0	
5	4.0	6.5	0	0					0	

Appendix D Macroinvertebrate taxa list

Species	Sites									
	1	2	3	4	5	6	7	8	9	10
Archichauliodes diversus	23	58		23	5	70		44	6	12
Xanthocnemis zealandica	5						18			
Ameletopsis perscitus								9	3	4
Acanthophlebia cruentata										1
Austroclima sepia	5	12		23	13	80	53	53	67	31
Austronella planulata								9		
Deleatidium spp.	7	198		12	47	55		9		58
Coloburiscus humeralis					50	40		18	3	51
Neozephlebia scita					7					
Nesameletus sp.					2	20			13	35
Oniscigaster wakefieldi								1		
Rallidens mcfarlanei						1		1		
Zephlebia spp.					2	10	9	61		16
Zephlebia borealis	16				6					
Zephlebia dentata	12	58		47	33		26	18		1
Zephlebia inconspicua					1					19
Zephlebia spectabilis					7				6	
Austroperla cyrene					2					
Megaleptoperla diminuta		1								
Megaloptoperla grandis									1	
Zelandobius spp.						10				
Zelandoperla decorata					8	5				1
Aoteapsyche spp.			23	6		100		53		12
Aoteapsyche catherinae			1							
Aoteapsyche colonica	5	1		53		75		18	10	
Helicopsyche spp.					6					16
Hudsonema alienum			1				1	9	3	
Hudsonema amabilis	7	35				5		70		4
Hydrobiosella mixta					5					1
Hydrobiosis spp.						1				4
Hydrobiosis copis								1		
Hydrobiosis parumbripennis						1				
Hydrobiosis gollanis										4
Neurochorema spp.					1	15		18	13	4
Neurochorema armstrongi									1	
Neurochorema confusum						10				

Species	Sites									
	1	2	3	4	5	6	7	8	9	10
Olinga feredayi	12	70								
Orthopsyche spp.		23			9					
Orthopsyche fimbriata					2				3	4
Orthopsyche thomasi	5									
Oxyethira albiceps			58	6		40	341	44	22	
Paroxyethira sp.			23				9	18		
Polyplectropus sp.					1			18		
Psilochorema sp.					1					
Pycnocentria evecta		23	280		1	10		464		16
Pycnocentrodes spp.	26	2543	642	53		135		26	337	16
Triplectides obsoletus /dolichos	12	1	12			15	53			1
Zelolessica cheira										4
Elmidae (larvae)	2	58		257	2	95	9	473	6	8
Elmidae (adult)								18		
Hydraenidae (A)					2	5				
Ptilodactylidae (larvae)		1								1
Rhantus sp.							1			
Aphrophila neozelandica					2	40			6	1
Austrosimulium sp.				41	1		9	9	10	43
Chironomus zealandicus	35									
Corynoneura sp.	5						26			
Cricotopus spp.	2		47			15	35	18	25	
Eriopterini sp.								1		
Eukiefferiella sp.	5									
Harrisius pallidus					1					
Kaniwhaniwhanus sp.								9		
Limonia nigrescens	7								1	
Lobodiamesinae									3	
Macropelopiini sp. = Tanypodinae	19				1	25		53	1	1
Muscidae			12						10	
Naonella forsythi						5	18		6	
Paradixa sp.	2				1	5	26			
Paralimnophila skusei	2				1			1		
Polypedilum spp.							18			1
Tabanidae						5				
Tanytarsus spp.			35			30	105	26	76	
Tanyderidae								1		
Zelandotipula sp.	2									

Species	Sites									
	1	2	3	4	5	6	7	8	9	10
Potamopyrgus antipodarum	98	758	1540	706	4	90	1374	219	10	778
Physa sp.				6			1			
Latia sp.			12	12	1	5			6	31
Lymnaea sp.							9			
Sphaerium sp.	21									
Oligochaeta	40			1	1					
Planaria	19				7					
Ostracoda	44	1					26			
Paracalliope fluviatilis						1	53			
Paranephrops planifrons		1			1					