Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2016-2017

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Executive summary

Section 35 of the Resource Management Act requires local authorities to undertake monitoring of the region's environment, including land, air, and fresh and marine water quality. The Taranaki Regional Council initiated the freshwater biological component of the State of Environment Monitoring (SEM) programme for Taranaki in the 1995-96 monitoring year. The macroinvertebrate component was separated from the microfloral component in the 2002-03 year. The latter programme was broadened to incorporate recently-developed techniques and is reported separately.

Freshwater macroinvertebrates are a range of aquatic species that have a crucial role in freshwater ecology and that respond to changes in water quality or hydrological patterns or habitat. While a grab sample of water collected from the waterbody will reveal water chemistry at the time of sampling, and thus give an indication of contemporaneous pressures on the ecology of the stream, the alternative of assessing the state of the freshwater communities themselves will show the cumulative influences of these factors over the recent past as well as being a primary indicator of whether a stream is healthy or otherwise. The Macroinvertebrate Community Index (MCI) is a New Zealand version of an approach that is used internationally. Each species found at a stream monitoring site is scored according to its sensitivity or tolerance, and the cumulative score then provides an index of stream health. The *Government's National Policy Statement for Freshwater Management 2017* requires every regional council to monitor and report on stream health using the MCI.

This report covers the 2016-2017 monitoring year. Biological surveys were performed in spring (October to December 2016) and summer (February to March 2017). Each seasonal survey assessed the macroinvertebrate communities at 59 sites in 26 rivers and streams. Two new sites were added in the 2015-2016 year, in the upper Waitara River and in the lower Whenuakura River, because of the need for the Council put in place adequate representative monitoring of the region's proposed Freshwater Management Units (as required by the National Policy Statement on Fresh Water).

The Hangatahua (Stony) River was selected as a river with high conservation value and the Maketawa Stream was selected for its regionally important recreational value. The Waitara, Manganui, Patea, Waiwhakaiho and the Mangaehu Rivers were chosen as examples of waterways with large catchments and multiple human impacts, arising in either the Egmont National Park or the eastern hill country. The Waingongoro River was included in the programme as a river under intensive usage with more recent wastes diversions out of the river, and the Waiongana Stream as a stream from which there is a major water abstraction (although not currently exercised). The Timaru, Mangaoraka, Waiokura (added in 2007) and Punehu Streams were included as streams within primary agricultural catchments. The Kaupokonui River, Mangorei Stream and Waimoku Stream were selected to monitor the progress of riparian planting in these catchments. These catchments had been targeted in management policies for riparian planting initiatives. The Katikara and Kapoaiaia streams are western Taranaki streams also targeted for riparian planting initiatives, and have been part of the monitoring programme since 2000. The Tangahoe River was included in 2007 to monitor land use changes in an eastern hill country catchment. The Kurapete Stream was added to the programme as an example of a small seepage ringplain stream where significant improvements to a major point source discharge have been implemented. The Waiau Stream is an example of a northern lowland catchment. The Mangawhero and Mangati Streams were selected as examples of small, degraded streams. The Huatoki Stream was selected as an example of a stream influenced by urbanisation and also in part by riparian vegetation while the Herekawe Stream, on the western outskirts of the New Plymouth urban area (with a lengthy consent monitoring record), has been added in order to monitor the impact of relatively recent community walkway planting initiatives. The Whenuakura River was selected as a large river draining the eastern hill country.

During the 2016-2017 period, only 32 of the 59 sites could be sampled due to persistently high spring flows though all 59 sites were sampled during the summer period. For sites located in lower catchments the proportion of 'sensitive' taxa in the macroinvertebrate communities generally have been lower in summer than in spring, coincident with lower flows, higher water temperatures, less scouring, and increased smothering of habitats by more widespread algal growth within rivers and streams in summer. The median spring MCI score (99 units) was one unit lower than the median summer score (100 units), with the mean (average) spring score 5 units higher. The seasonal difference in scores was not ecologically or statistically significant. There was no data from 27 sites from the spring survey but this did not affect the spring median score as it was identical (99 units) to the long term spring median (1995-2017). While 14 sites had MCI scores that were higher in spring than in summer, there were actually more (15) that showed an increase in their summer scores.

The proportion of 'sensitive' taxa in the macroinvertebrate communities decreased down the length of the waterways, which was reflected in the deterioration in generic stream 'health' from 'very good' in the upper reaches to 'good' through to 'fair' in mid-reaches to 'fair' in the lower reaches.

A moderate number of sites (six sites) recorded new historical maximum MCI scores, while one site recorded a decrease in historical minimum score in the 2016-2017 period. Two of the six new maximum records and the one minimum record were from the two sites established in the 2015-2016 period and hence were of little comparative significance.

Evaluations of generic stream 'health' have been performed and assessments of current scores compared with predictive measures based on distance from the Egmont National Park boundary (a model based on regional data) and in relation to a River Environment Classification (REC) predictive model (which is based on national data). Generally there was good agreement between current scores and both of the predictive models, though the distance predictive model more closely matched current scores compared with the REC predictive model.

The trends through time have been evaluated and will continue to be assessed on an annual basis as the SEM programme continues. Taking into account the full historical record for each site, there were 57 sites with trend data (based on the complete monitoring record of a minimum of more than10 years' monitoring data).

Eight sites had indicative deteriorating trends, with only one of those trends being a statistically significant deterioration in MCI score (a result of headwater erosion effects inside the National Park). In contrast, forty-nine sites had indicative positive trends, with thirty of those sites having statistically significant improvements, all but two of which have also been of ecological importance. That is, not only is there confidence that the observed trends are real, but the degree of change that has occurred in the state of the in-stream communities is substantial. In all, 31 sites had a statistically significant trend (after application of FDR tests[1]).

There was little evidence of trends in macroinvertebrate health at sites in the upper reaches of catchments, which generally already had good macroinvertebrate health, while over two-thirds of middle reach sites had significant improvement and approximately half the sites located in the lower reaches of catchments showed significant improvement. Generally, in lower catchment sites the macroinvertebrate communities tend to be 'tolerant' of the cumulative impacts of nutrient enrichment. Significant improvement of (predominantly 'fair') biological stream 'health' at the lower reach sites is unlikely to be detected until habitat improvements occur by way of substantial catchment-wide initiatives such as riparian planting and diversion of point source surface water dairy treatment ponds systems wastes discharges to land irrigation.

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[1] FDR= False Discovery Rate, one of several tests applied to the results to increase confidence in the results by eliminating apparent trends that are the results of co-incidence and random distributions rather than genuine change.

(It is noted that the Council is promoting these interventions with implementation by the regional community).

Taking into account the most recent ten-year data set, there were seven sites showing significant improvements prior to FDR adjustment being applied, but none of these trends could still be deemed significant after FDR adjustment. This may be due to several factors. Firstly, trends have plateaued recently at some site, which may have been the result of riparian management initiatives having largely been completed in some catchments, or the effects of point source discharge removal having subsequently stabilised. Secondly, substrate instability and sedimentation caused by extensive headwater erosion events in recent years have affected the macroinvertebrate communities at upper sites in the Stony River (in particular), Katikara Stream, Maketawa Stream, Waiwhakaiho River, and Timaru Stream on occasions within this period. Most of these sites did continue to show recovery from these impacts during the current period. Thirdly, the smaller dataset has less power to support the assessment of differences being statistically significant within a background of natural fluctuations, even if real ecological improvements are occurring.

The recommendations for the 2017-2018 monitoring year provide for the freshwater biological component of the SEM monitoring to be maintained by way of the same macroinvertebrate faunal programme and for time trend reporting on the full data set and the most recent ten year dataset (to detect recent trends) to be performed annually.

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1 Introduction

The Resource Management Act 1991 (RMA) established new requirements for local authorities to undertake environmental monitoring. Section 35 of the RMA requires local authorities to monitor, among other things, the state of the environment of their region or district, to the extent that is appropriate to enable them to effectively carry out their functions under the Act.

To this effect, the Taranaki Regional Council ('the Council') has established a state of the environment monitoring (SEM) programme for the region. This programme is outlined in the Council's 'State of the Environment Monitoring Procedures Document', which was prepared in 1997. The monitoring programme is based on the significant resource management issues that were identified in the Council's Regional Policy Statement for Taranaki (1994).

The SEM programme is made up of a number of individual monitoring activities, many of which are undertaken and managed on an annual basis (from 1 July to 30 June). For these annual monitoring activities, summary reports are produced following the end of each monitoring year (i.e., after 30 June). Where possible, individual consent monitoring programmes have been integrated within the SEM programme to save duplication of effort and minimise costs. The purpose of annual SEM reports is to summarise regional environmental monitoring activity results for the year, and provide an interpretation of these results, together with an update of trends in the data.

Annual SEM reports act as 'building blocks' towards the preparation of regular regional state of the environment reports. The Council's first, or baseline, state of the environment report was prepared in 1996 (TRC, 1996c), summarising the region's progress in improving environmental quality in Taranaki over the past two decades. The second regional state of the environment report was published (TRC, 2003) and discussed the data gathered over the inaugural five year monitoring period. With the completion of the first ten years of the programme in mid 2005, a report on trends (at 60 sites) in biological stream 'health' was completed (Stark and Fowles, 2006), with a subsequent report focusing on the interpretation of significant trends (TRC, 2006). The third regional state of the environment report published in 2009 (TRC, 2009a) encompassed data from 1995 to 2007 and included trending (at 53 sites) for the twelve year period. The fourth regional state of the environment report published in 2015 (TRC, 2015) includes data trended for the 18-year period (to mid 2013) at 53 of the 57 sites. Subsequent annual SEM reports consider trends in stream health for all sites as the data record for each monitoring activity increases with time.

This report summarises the results for the sites surveyed in the freshwater macroinvertebrate SEM programme over the 2016-2017 monitoring year, the twenty-second year of this programme.

Freshwater macroinvertebrates are a range of aquatic species that have a crucial role in freshwater ecology and that respond to changes in water quality or hydrological patterns or habitat. While a grab sample of water collected from a waterbody will reveal water chemistry at the time of sampling, and thus give an indication of any contemporaneous pressures on the ecology of the stream, the alternative of directly assessing the state of the freshwater communities themselves will show the cumulative influences of these factors over the recent past as well as being a primary indicator of whether a stream can be considered healthy or otherwise. The Macroinvertebrate Community Index (MCI) is a New Zealand version of an approach that is used internationally. Each species found at a stream monitoring site is scored according to its sensitivity or tolerance, and the cumulative score then provides an index of stream health. The *Government's National Policy Statement for Freshwater Management 2017* made it compulsory for every regional council to monitor and report on stream health using the MCI.

The Cawthron Institute notes: *Benthic macroinvertebrates are used worldwide as sub-indicators of stream ecosystem health as they respond to human pressures, are taxonomically diverse and easy to sample. The MCI is responsive to multiple stressors, but not all stressors, and as such provides a good indicator of the overall condition of the macroinvertebrate component of stream ecosystem health*[2].

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[2] Cawthron Institute Report 3073

2 Monitoring activity

2.1 Introduction

The Council commenced the freshwater biological SEM programme in spring 1995. The 2016-2017 monitoring year was therefore the twenty-second year in which this SEM programme was undertaken. This report presents the results from the sites surveyed in the 2016-2017 monitoring year. The methodology for the programme is fully described in TRC (1997b) and summarised below.

2.2 Monitoring methodology

The standard '400 ml kick-sampling' and rarely the '400 ml sweep-net- sampling' techniques were used to collect streambed (benthic) macroinvertebrates from various sampling sites in selected catchments in the Taranaki region (detailed in section 2.4 and TRC, 1997b). The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) and the 'sweep-net- sampling' technique is very similar to Protocol C2 of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001). Surveys of all sites are normally performed twice during the monitoring year, once during spring (October to December) and once during summer (February and March). Sampling dates for each site are detailed in Table 3.

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). Macroinvertebrate taxa were placed in abundance categories for each sample (Table 1).

Table 1 Macroinvertebrate abundance categories

Abundance category	Number of individuals
R (rare)	1-4
C (common)	5-19
A (abundant)	20-99
VA (very abundant)	100-499
XA (extremely abundant)	500+

2.3 Environmental parameters and indicators

2.3.1 Taxonomic richness

The number of macroinvertebrate taxa found in each sample is used as an indicator of the richness of the community at each site. A high taxonomic richness does not necessarily mean a pristine, healthy community. Sites with mild nutrient enrichment will often have higher taxonomic richnesses than pristine sites and therefore caution is required when evaluating sites based on taxonomic richness (Stark and Maxted, 2007).

2.3.2 Macroinvertebrate Community Index (MCI)

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience (see TRC, 1997b). By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways.

A refinement of Stark's classification (Stark, 1985, Boothroyd and Stark, 2000; and Stark and Maxted, 2007) has been made in order to grade the biological 'health' based upon MCI and $SQMCI_s$ ranges. This gradation is presented in Table 2.

Table 2 Generic MCI gradation of biological water quality conditions adapted for Taranaki streams and rivers

TRC Grading	MCI	$SQMCI_s$	Colour Code	Stark's classification
Excellent	>140	>7.00		Excellent
Very Good	120-140	6.00-7.00		
Good	100-119	5.00-5.99		Good
Fair	80-99	4.00-4.99		Fair
Poor	60-79	3.00-3.99		Poor
Very Poor	<60	<3.00		

This generic adaption is considered to provide more resolution of stream 'health' in the context of more precise upper and lower MCI and $SQMCI_s$ score bands, than the earlier grading classification (Stark and Fowles, 2015). Despite the acknowledgement that the boundaries between gradings may be fuzzy (Stark and Maxted, 2007), these gradings can assist with the assessment of trends in long term temporal data.

When the same number of replicate samples are collected per site, the detectable difference method may be used to assess the significance of MCI score differences. Stark (1998) provides statistically significant detectable differences for the protocols used by TRC (10.8 MCI units). Therefore, if differences between MCI scores are greater than ten units, then they can be considered significantly different. In practice this means a result more than 10 units above a score would be regarded as significantly higher, and a result more than 10 units below a score would be significantly lower. Between season and long term median MCI scores and/or taxa richnesses may also be compared using t-tests (Stark and Maxted, 2007).

2.3.2.1 Predictice measures using the MCI

Data from ringplain rivers and streams that source of flow was within Egmont National Park was used to establish a relationship between MCI scores and distance from stream/river source (National Park boundary) on the ringplain. A generic relationship for predicting MCI in ringplain streams/rivers has been established as:

$MCI = 131.717 - 25.825 \log_{10} D$ [where D = distance from source (km)]

and is based upon more than 2400 TRC surveys of about 300 ringplain 'control' sites over the period from 1980 to 2008. This generic predictive relationship has a margin of error of ±10 units (Stark and Fowles, 2009).

River and stream data from throughout the Taranaki Region for 'control' sites from both SEM and compliance monitoring has also been compiled and useful statistics produced based on steam type and altitude (TRC, 2016c). This data has the advantage that it also contains data for all rivers and streams and is based on raw data and therefore is not as constrained as a predictive value produced by a mathematical equation.

Leathwick (2009, pers comm.) has also developed predictive scores based upon the River Environmental Classification (REC) system for New Zealand rivers and streams (Snelder et al, 2004). REC classifies and maps river and stream environments in a spatial framework for management purposes. It provides a context for inventories of river/stream resources and a spatial framework for effects assessment, policy development, developing monitoring programmes, and interpretations of state of the environment reporting.

2.3.3 Semi Quantitative MCI ($SQMCI_s$)

A semi-quantitative MCI value ($SQMCI_s$) (Stark 1998 & 1999) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998, 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of more than 0.83 units is considered statistically significant. In this report, the index is used to emphasize the numerical dominance of certain taxa where this is relevant to the interpretation of community structure. However, Stark and Maxted (2007) considered the MCI to be a more appropriate index than the $SQMCI_s$ for State of the Environment monitoring and discussion, and in this report emphasis will be placed on the MCI.

2.4 Trend analysis

State of the environment (SEM) macroinvertebrate data collected at SEM sites in the region over the twenty-two year (1995-2017) and last ten-year (2007-2017) periods under standard TRC programme protocols were analysed for trends over time. The MCI, a surrogate for stream health, was selected as the most appropriate index for use in the assessment of time trends (see Stark and Maxted, 2007).

MCI trend data was first visually inspected using a scatter plot of MCI data vs time with LOWESS [Locally Weighted Scatterplot] fit (tension of 0.4) to create a smoothed, moving average trendline.

MCI data was then statistically analysed for trends over time using the Mann-Kendall test at the 5% level of significance ('cut-off' point) and 1% level of significance ('highly significant'), followed by false discovery rate (FDR) analysis for sites with a minimum of ten years continuous data recorded (Stark and Fowles, 2006). The significance of a site's trend (i.e. the strength of the trend) was calculated according to the statistical probability of occurrence (p-value), as long as similar numbers of samples were collected for analysis, which has been the case with the TRC programme. A Kendall tau coefficient was also produced which indicated whether the trend was positive or negative and the magnitude of the trend. It should be noted that to enable historic comparisons some non-SEM samples for some sites are used in trend analyses.

A trend may be statistically significant but have no ecological importance, or vice versa. The consideration of ecological importance may be supported by best professional judgment (BPJ) of a freshwater ecologist with knowledge of the region's rivers and streams. However, it is likely that the strongest trends (lowest p-values) would also have the greatest ecological importance.

In relation to the indicator of stream 'health', the MCI, the estimation error for this index is 10.8 units (Stark 1998) for the sampling protocols used by TRC. Therefore, although a statistically significant temporal trend may be found for a site's data, if the LOWESS range of MCI scores is less than 11 units, the best professional judgment may eliminate this from a list of ecologically significant results. Also, to place these trends in perspective, each site may be assessed against graduations (bands of MCI values) of stream health. In this instance, Stark's (1985) categories have been refined (using BPJ) as illustrated in Table 2 in Section 2.3.3 above (Stark & Fowles, 2015).

2.5 Site locations

All sites in the freshwater biological SEM programme for the Taranaki region are illustrated in Figure 1 and described in Table 3. The biological programme for the 2016-2017 period involved the continuation of a riparian vegetation monitoring component incorporating five sites in the Kaupokonui River (see Table 3) and five sites in western Taranaki ring plain streams (Katikara Stream and Kapoaiaia Stream). Evaluations of the effects of, and recovery from, extensive erosion in the headwaters of the Waiaua River had been included in this programme. These surveys commenced in December 1998 and the two sites on the Waiaua River were incorporated into the SEM biological monitoring programmes since the initial documentation of the effects and recovery was established. This river continued to be affected by headwater erosion in more recent years. Therefore, the programme was reviewed in 2006 and the Waiaua River excluded from the SEM programme. The Kurapete Stream (upstream and 5.5km downstream of the Inglewood oxidation pond system) has been monitored throughout the SEM period, using the appropriate SEM protocols, and has been included in the programme. Two additional sites in the Waiwhakaiho River catchment were included in 2002-2003 in recognition of the importance of this major catchment. A further two additional eastern hill country sites in the Whenuakura and Waitara Rivers were added in 2015-2016 to improve the representativeness of the monitoring programme, particularly in the light of the requirement of the National Policy Statement on Fresh Water that the Council undertakes representative monitoring across all Freshwater Management Units within the region. The Council has identified prospective FMUs and has adjusted its monitoring programmes in anticipation of these being confirmed in due course within the forthcoming *Regional Water and Land Plan* (in prep).

Table 3 Freshwater biological monitoring sites in the State of the Environment Monitoring programme

River/stream	Site	Site code	GPS location		Spring date	Summer date
			E	N		
Hangatahua (Stony) R	Mangatete Road	STY000300	1677460	5657823	NA	1 Mar 17
Hangatahua (Stony) R	SH45	STY000400	1674632	5661558	NA	1 Mar 17
Herekawe S	Centennial Drive	HRK000085	1688283	5674972	NA	16 Feb 17
Huatoki S	Hadley Drive	HTK000350	1693349	5671486	NA	8 Mar 17
Huatoki S	Huatoki Domain	HTK000425	1693041	5673404	NA	8 Mar 17
Huatoki S	Molesworth St	HTK000745	1692800	5676424	NA	8 Mar 17
Kapoaiaia S	Wiremu Road	KPA000250	1678009	5652025	4 Oct 16	3 Mar 17
Kapoaiaia S	Wataroa Road	KPA000700	1672739	5652272	4 Oct 16	3 Mar 17
Kapoaiaia S	Cape Egmont	KPA000950	1665690	5652452	4 Oct 16	3 Mar 17
Katikara S	Carrington Road	KTK000150	1683566	5657855	NA	16 Feb 17
Katikara S	Beach	KTK000248	1676597	5667473	NA	16 Feb 17
Kaupokonui R	Opunake Road	KPK000250	1698088	5639231	19 Oct 16	10 Feb 17
Kaupokonui R	U/s Kaponga oxi ponds	KPK000500	1698609	5634423	19Oct 16	10 Feb 17
Kaupokonui R	U/s Lactose Co.	KPK000660	1697613	5629791	19 Oct 16	10 Feb 17
Kaupokonui R	Upper Glenn Road	KPK000880	1693026	5622705	19 Oct 16	10 Feb 17
Kaupokonui R	Near mouth	KPK000990	1691209	5620444	19 Oct 16	10 Feb 17
Kurapete S	U/s Inglewood WWTP	KRP000300	1705087	5665510	NA	16 Feb 17
Kurapete S	D/s Inglewood WWTP	KRP000660	1709239	5667481	NA	16 Feb 17

River/stream	Site	Site code	GPS location		Spring date	Summer date
			E	N		
Maketawa S Maketawa S	Opp Derby Road Tarata Road	MKW000200 MKW000300	1702192 1708784	5656304 5665231	NA NA	15 Feb 17 15 Feb 17
Mangaehu R	Raupuha Rd	MGH000950	1726300	5639062	4 Nov 16	7 Mar 17
Manganui R Manganui R	SH3 Bristol Road	MGN000195 MGN000427	1708871 1711210	5651282 5667887	22 Dec 16 22 Dec 16	23 Feb 17 23 Feb 17
Mangaoraka S	Corbett Road	MRK000420	1702538	5676320	NA	15 Feb 17
Mangati S Mangati S	D/s railway line Te Rima Pl, Bell Block	MGT000488 MGT000520	1700095 1699385	5678043 5679103	NA NA	1 Mar 17 1 Mar 17
Mangawhero S Mangawhero S	U/s Eltham WWTP D/s Mangawharawhara S	MWH000380 MWH000490	1712475 1710795	5633431 5632738	18 Oct 16 18 Oct 16	14 Feb 17 14 Feb 17
Mangorei S	SH3	MGE000970	1696094	5671500	NA	24 Feb 17
Patea R Patea R Patea R	Barclay Rd Swansea Rd Skinner Rd	PAT000200 PAT000315 PAT000360	1702620 1711801 1715919	5646598 5644382 5644681	18 Dec 16 18 Dec 16 18 Dec 16	22 Mar 17 22 Mar 17 22 Mar 17
Punehu S Punehu S	Wiremu Rd SH45	PNH000200 PNH000900	1687323 1677946	5637020 5627786	19 Oct 16 19 Oct 16	8 Mar 17 8 Mar 17
Tangahoe R Tangahoe R Tangahoe R	Upper Valley Tangahoe Vly Rd bridge d/s rail bridge	TNH000090 TNH000200 TNH000515	1725340 1719126 1715751	5626101 5622681 5612470	14 Dec 16 14 Dec 16 14 Dec 16	20 Mar 17 20 Mar 17 20 Mar 17
Timaru S Timaru S	Carrington Road SH45	TMR000150 TMR000375	1684423 1679509	5659634 5665554	NA NA	14 Feb 17 14 Feb 17
Waiau S	Inland North Road	WAI000110	1714587	5680018	NA	15 Feb 17
Waimoku S Waimoku S	Lucy's Gully Beach	WMK000100 WMK000298	1681324 1681725	5666240 5669851	NA NA	14 Feb 17 14 Feb 17
Waingongoro R Waingongoro R Waingongoro R Waingongoro R Waingongoro R Waingongoro R	700m d/s Nat Park Opunake Rd Eltham Rd Stuart Rd SH45 Ohawe Beach	WGG000115 WGG000150 WGG000500 WGG000665 WGG000895 WGG000995	1700835 1705692 1710576 1709784 1704042 1702531	5645086 5642523 5634824 5632049 5618667 5617624	18 Oct 16 18 Oct 16 18 Oct 16 18 Oct 16 18 Oct 16 18 Oct 16	14 Feb 17 14 Feb 17 14 Feb 17 14 Feb 17 14 Feb 17 14 Feb 17
Waiokura S Waiokura S	Skeet Rd Manaia Golf Course	WKR000500 WKR000700	1698807 1697636	5628892 5622019	19 Oct 16 19 Oct 16	10 Feb 17 10 Feb 17
Waiongana S Waiongana S	SH3a Devon Road	WGA000260 WGA000450	1705159 1704063	5669554 5680381	NA NA	15 Feb 17 15 Feb 17
Waitara R Waitara R	Autawa Road Mamaku Road	WTR000540 WTR000850	1720719 1708384	5663669 5678739	9 Dec 16 9 Dec 16	1 Mar 17 1 Mar 17
Waiwhakaiho R Waiwhakaiho R Waiwhakaiho R Waiwhakaiho R	National Park SH3 (Egmont Village) Constance St (NP) Adjacent to L Rotomanu	WKH000100 WKH000500 WKH000920 WKH000950	1696096 1698297 1695827 1696587	5658351 5666893 2677271 2678336	NA NA NA NA	15 Feb 17 15 Feb 17 15 Feb 17 15 Feb 17
Whenuakura R	Nicholson Rd	WNR000450	1732757	5598479	14 Dec 16	20 Mar 17

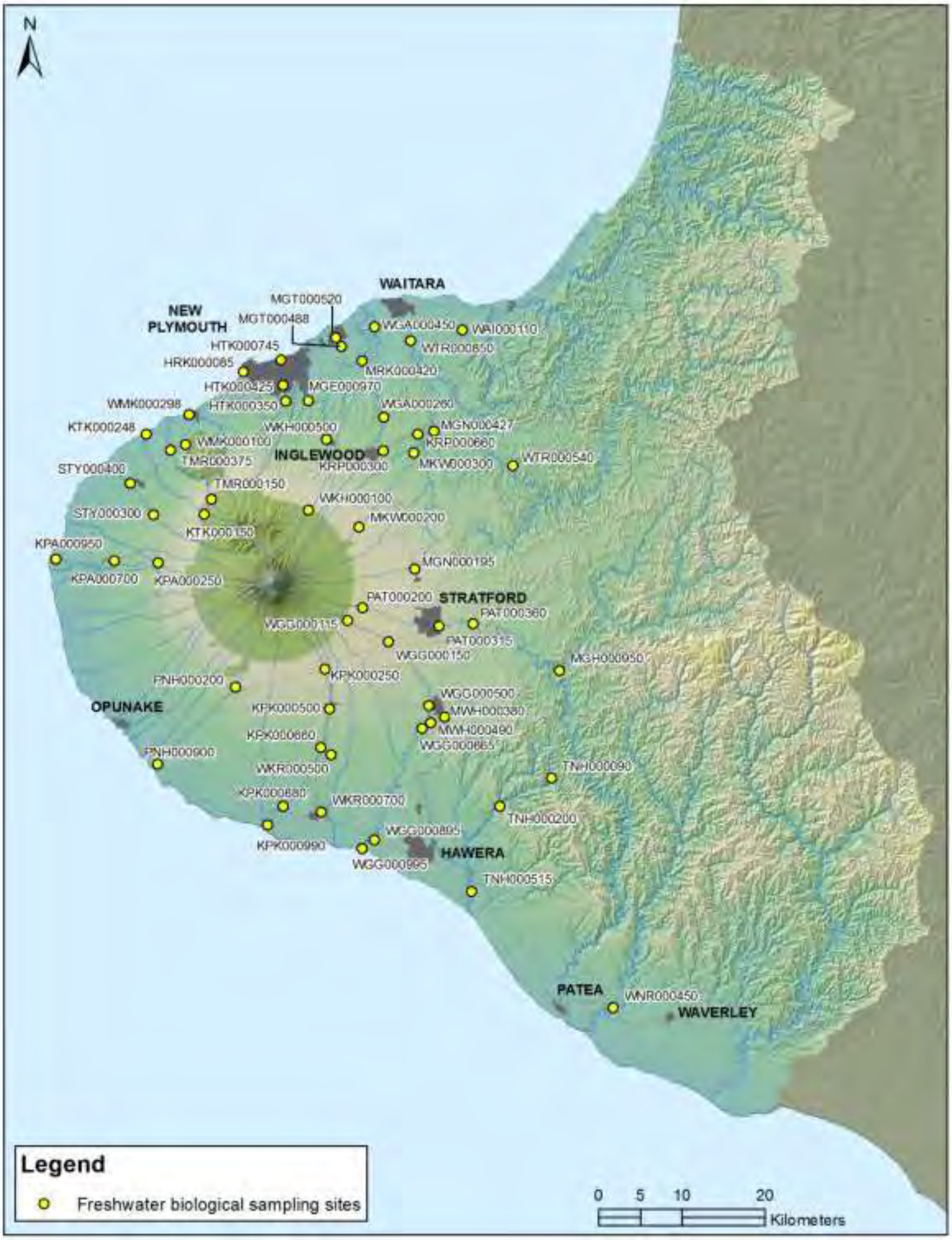


Figure 1 Location of macroinvertebrate fauna sampling sites for the 2016-2017 SEM programme

Two sites in the Maketawa Stream were also added as a result of a commitment to continue the documentation of conditions in this catchment following the investigation of baseline water quality conditions during the 2000-2002 period (Stark, 2003). Three sites in the Tangahoe River were established in the 2007-2008 period for the purposes of monitoring land use changes (afforestation) in an eastern hill country catchment. The two sites in the Waiokura Stream were also added in the 2007-2008 period as a long term monitoring commitment to the collaborative best practice dairying catchment project. One site in the Herekawe Stream (a long term consent monitoring site) was incorporated into the programme in the 2008-2009 period for the purpose of monitoring the local initiatives of walkway establishment and riparian planting of this small catchment on the western outskirts of the New Plymouth urban area.

The Hangatahua (Stony) River was selected for the SEM programme as a waterway of high conservation value. The headwaters of the river are the Ahukawakawa swamp within Egmont National Park, and several tributaries that begin above the tree line on the north-west of Mount Taranaki. Once the river leaves the National Park boundary its catchment becomes very narrow so that it receives little water from surrounding farmland before reaching the sea. This factor and the protection order on the catchment maintains good water quality in the river. However, ecological degradation occurs from time to time after headwater erosion events when sedimentation and scouring of the riverbed may be particularly severe. The sites at Mangatete Road and State Highway 45 are approximately seven kilometres and twelve kilometres downstream of the National Park boundary respectively.

The Timaru and Mangaoraka Streams were chosen for the SEM programme as examples of streams within primary agricultural catchments. The Timaru Stream arises within the National Park boundary, near the peak of Pouakai, in the Pouakai Range. Upon leaving this range, the stream flows along the edge of the Kaitake Range (also part of the National Park) and receives several tributaries that flow through adjacent agricultural land. From the edge of the Kaitake Range, the stream flows north through agricultural land to the sea. Carrington Road crosses the stream within the National Park boundary and State Highway 45 is six kilometres downstream of the confluence with the first farmland tributary. The Mangaoraka Stream rises below the National Park boundary near Egmont Road and flows north through farmland for its entire length before joining the Waiongana Stream near the coast. Corbett Road is 26 kilometres downstream of the source.

The Waiongana Stream was included in the SEM programme as an example of a stream with a major water abstraction. The stream originates within the National Park, near the North Egmont visitor’s centre. After crossing the park boundary, it flows north-east through agricultural land to the sea. State Highway 3a crosses the stream fifteen kilometres downstream of the National Park boundary, and the intake for the Waitara industrial water supply is a further five kilometres downstream of that. Devon Road is 30 kilometres downstream of the National Park boundary.

The Waiwhakaiho, Manganui, Waitara, and Mangaehu Rivers were selected for the SEM programme as examples of waterways with large catchments and multiple impacts from human land uses including plantation forestry, rural, urban and industrial activities. They arise either on Mt Taranaki or in the eastern hill country, before flowing across the ring plain.

The Waiwhakaiho River and its headwater tributaries arise above the tree line on the north face of Mount Taranaki. Upon leaving the National Park, the river flows north through agricultural and industrial land for 27 kilometres to the sea. The river passes under State Highway 3 near Egmont Village, nine kilometres downstream of the National Park boundary. The sites at Constance Street and adjacent to Lake Rotomanu are included in the lower Waiwhakaiho River industrial discharges monitoring programme. The site adjacent to Lake Rotomanu has replaced the site immediately downstream of the Mangaone Stream that was used in the 1995-96 State of the Environment monitoring survey. This allows the State of the Environment monitoring programme to better integrate with the industrial monitoring programme. The Mangorei Stream is the principal tributary catchment in the lower reaches, downstream of the major abstraction of water for hydroelectric and community supply purposes. Occasional headwater erosion events have been documented in the upper river with an instance of severe (orange) discolouration in spring 2014 due to release of naturally occurring iron oxide from a small headwater tributary.

The source of the Manganui River is situated above the tree line on the eastern slopes of Mount Taranaki. After leaving the National Park, the river flows east and then north through agricultural land for 44 kilometres before joining the Waitara River. State Highway 3 is eight kilometres downstream of the National Park boundary. At Tariki Road, much of the flow of the Manganui River is diverted through the Motukawa hydroelectric power scheme to the Waitara River. Therefore, except when the Tariki weir is overtopping, most of the water in the Manganui River at Bristol Road (14 kilometres downstream of the diversion) comes from tributaries such as the Mangamawhete, Waitepuke, Maketawa, and Ngatoro Streams. Like the Manganui River, these streams originate high on the eastern slopes of Mount Taranaki. They flow through agricultural land before joining the river. The Maketawa Stream provides a valued trout and native fish habitat. Sites were included in the upper and lower reaches of the stream.

The small Kurapete Stream, which rises as seepage to the west of Inglewood, was included to monitor trends in relation to the removal of the town's Wastewater Treatment Plant's discharge from this tributary of the lower Manganui River in 2000. Sites were included upstream and nearly six km downstream of where the discharge was located.

The Waitara River flows south-west and then north-west out of the eastern hill country through a mix of agricultural land and native forest before passing through the town of Waitara and out to sea. It has a different character from the steep ring plain rivers and carries a high silt load. The Autawa Road site is located 46 km from the coast. This site was only added during the 2016-2017 reporting period, to increase the number of eastern hill country sites being monitored. The Mamaku Road site is located six km upstream of the coast above any tidal influence. This site is also part of the monitoring programme for the stormwater discharge from the Waitara Valley Methanex plant to the Waitara River.

The Mangaehu River originates in the eastern hill country and flows south-west through agricultural land for most of its length before joining the Patea River, ten kilometres upstream of Lake Rotorangi. Raupuha Road crosses the river less than one kilometre upstream of the confluence with the Patea River.

The Tangahoe River is a smaller eastern hill country catchment which flows through agricultural land, some of which has undergone afforestation in the upper reaches. Fonterra extracts dairy company processing waters in the lower reaches near the coast, south of Hawera township.

The Whenuakura River is an eastern hill country river which primarily flows through agricultural land. It has a high silt load and is consequently highly turbid. The only site located on the Whenuakura River at Nicholson Road was included during this reporting period, to increase the number of eastern hill country rivers being monitored.

The Mangati Stream was chosen for the SEM programme as an example of a small, degraded stream. Only five kilometres in length, the stream rises in farmland and flows north through the Bell Block industrial area and suburbs to the sea. The site downstream of the railway line is upstream of all industrial discharges to the stream. The site at Te Rima Place is located within a suburban park, downstream of all Bell Block industrial discharges. Both sites are part of the Mangati Stream industrial monitoring programme.

The Waimoku Stream originates in Egmont National Park where it flows down Lucy's Gully in the Kaitake Ranges. Once the stream leaves the park it flows through farmland for three and a half kilometres, and through the coastal township of Oakura for about 200 metres, before entering the sea. It was included in the SEM programme in the 1999-2000 monitoring year to monitor the effects of a riparian planting programme in the catchment. Sampling sites are located in Lucy's Gully under native forest, and in Oakura township, about 100 metres upstream of the sea.

The Waiau Stream originates in farmland near Tikorangi, and is a small catchment to the north of the Waitara River. It flows for 12.5 km to the sea. The stream was included in the SEM programme in the 1999-2000 monitoring year as an example of a northern lowland catchment. The sampling site at Inland North Road is located in a pasture setting.

The Punehu Stream is representative of a south-western Taranaki catchment subject primarily to intensive agricultural land use with water quality affected by diffuse source run-off and point source discharges from dairy shed treatment pond effluents particularly in the Mangatawa Stream, a small lower reach tributary. No industrial discharges to the stream system are known to occur. Both sites were Taranaki ring plain survey sites (TCC, 1984) and the lower site near the coast remains a NIWA hydrological recording station as a representative basin. The upstream site is representative of relatively unimpacted stream water quality although it lies approximately two km below the National Park boundary.

The small seepage fed, ringplain Waiokura Stream drains an intensively dairy-farmed catchment. The Fonterra, Kapuni factory irrigates wastewater within the mid reaches of this catchment. The catchment is the subject of a (five region) collaborative long term study of best practice dairying catchments (Wilcock et al, 2009).

The Patea River rises on the eastern slopes of Mt Taranaki, within the National Park and is a trout fishery of regional significance, particularly upstream of Lake Rotorangi (formed by the Patea dam) in its mid reaches. Site 1 (at Barclay Road) is representative of the upper catchment adjacent to the National Park above agricultural impacts. Site 2 (at Swansea Road), which is integrated with consent compliance monitoring programmes, was also a ring plain survey site, and is representative of developed farmland drainage and is downstream of Stratford township (urban run-off, but upstream of the rubbish tip and oxidation pond discharges and the combined cycle power station discharge). Site 3 (at Skinner Road) is an established hydrological recorder station downstream of these discharges and the partly industrialised Kahouri Stream catchment.

The Waingongoro River rises on the south-eastern slopes of Mount Taranaki within the National Park and is one of the longest of the ring plain rivers, with a meandering 67 km of river length from the National Park boundary prior to entering the Tasman Sea at Ohawe Beach. The river is the principal trout fishery in Taranaki and is also utilised for water abstraction purposes and up until mid 2010, received treated industrial and municipal wastes discharges in mid-catchment at Eltham. Site 1 (near the National Park boundary) is representative of high water quality conditions with minimal agricultural impacts. Site 2, six km further downstream (at Opunake Road) represents agricultural impacts, still in the upper reaches of the river while site 3 (at Eltham Road) a further 16 km downstream remains representative of the impacts of farmland drainage and some water abstraction while upstream of the former major Eltham point source discharges from a meatworks and the municipal wastewater treatment plant. The meatworks wastewaters were diverted to spring and summer land irrigation in the mid 2000s and treated plant wastewater subsequently has continued to be irrigated onto farmland in this manner. The Eltham municipal wastes were permanently diverted by pipeline to Hawera in June 2010. The Stuart Road site, a further six km downstream is located below these former discharges. A further two sites (SH45 and Ohawe Beach) are located 33 km and 37 km downstream of Stuart Road in the intensively developed farmland lower reaches of the catchment. River flow recording sites are located at Eltham Road and SH45.

The Mangawhero Stream is a relatively small, swamp-fed catchment rising to the east of Eltham in the Ngaere Swamp and draining developed farmland. The upper site is located in the mid reaches of the stream upstream of the former point source discharge from the Eltham municipal wastewater treatment plant while the lower site is located a further three km downstream, below the Mangawharawhara Stream confluence, near the confluence with the Waingongoro River. Apart from the municipal point source discharge, which was diverted out of the stream in July 2010 (see above), the catchment is predominantly developed farmland.

The Huatoki Stream was sampled as part of the State of the Environment monitoring programme for the first time in the 1997-1998 monitoring year. The stream rises one kilometre outside the National Park boundary on the foothills of the Pouakai Range. It flows through agricultural land for 12.5 km to the outskirts of New Plymouth where it enters native forest reserve. The stream flows for four and a half kilometres alongside walkways and beneath the central business district of New Plymouth before entering the sea next to Puke Ariki Landing. Within New Plymouth it flows through a culvert in a flood retention dam and over a small weir in the Huatoki Reserve prior to the business section of the city. Beautification works adjacent to 'Centre City' near the stream mouth (in 2010) involved the creation of a weir and fish pass immediately upstream of the lowest site which subsequently has altered the flow regime at this site and created a run-like habitat with intermittent flow variability rather than the previous riffle habitat.

The Herekawe Stream is a small seepage stream on the western boundary of New Plymouth. It drains a mainly urban catchment and receives stormwater discharges particularly in its lower reaches. Completion of a walkway and riparian planting community project now warrants the inclusion of the consent monitoring 'control' site at Centennial Drive for monitoring the effectiveness of these initiatives.

The Kaupokonui River rises on the southern slopes of Mt Taranaki within the National Park. It drains an intensively farmed dairy catchment. The principal point source discharges to the river occur in the mid-reaches from the Kaponga oxidation pond system, and cooling water from NZMP (Kapuni) Ltd. The river has patchy riparian vegetation cover and has been targeted for intensive riparian management initiatives. Site 1 is two and a half kilometres downstream of the National Park boundary and has high water quality, with minor agricultural impacts. Toward the mid-reaches, site 2 (six kilometres further downstream) is subject to some agricultural impacts, but is a short distance upstream of the Kaponga oxidation ponds' system discharge. A further six kilometres downstream, site 3 is upstream of wastes irrigation, cooling water discharges and factory abstraction. The Upper Glenn Road (site 4) is a further 10 km downstream, below all of the factory's activities and is a river flow hydrological recording site. The final site 5, is located near the mouth of the river, 5 km below site 4, upstream of any tidal influence at Kaupokonui beach domain camping ground.

Two western catchments, the Katikara Stream and Kapoaiaia Stream, were included in the programme to monitor trends in relation to riparian planting. Such riparian planting initiatives have been concentrated in certain catchments where past riparian vegetation has been sparce. The Katikara Stream rises on the western slopes of Mt Taranaki, passing through primarily agricultural land in the relatively short distance to the sea. The Kapoaiaia Stream also rises from Mt Taranaki on the western side and south of the Katikara Stream. The Kapoaiaia Stream drains agricultural land throughout its entire catchment below the National Park boundary, passing through Pungarehu township at SH45 before entering the sea at Cape Egmont. A hydrological telemetry recorder is located at Cape Egmont.

3 Results and discussion

3.1 Water temperature and flows

Spot water temperatures recorded at each site at the time of sampling during spring 2016 and summer 2017 SEM biomonitoring surveys are summarised in Table 4.

Table 4 Water temperature recorded at the times of SEM biological monitoring surveys

Watercourse	Spring 2016	Summer 2017
Hangatahua (Stony) River	NA	18.3-19.8
Herekawe Stream	NA	15.3
Huatoki Stream	NA	15.3-16.5
Kapoaiaia Stream	11.4-13.8	14.0-17.1
Katikara Stream	NA	11.9-14.5
Kaupokonui River	9.9-14.7	10.8-20.6
Kurapete Stream	NA	14.9-15.6
Maketawa Stream	NA	12.0-14.9
Mangaehu River	14.1	19.3
Manganui River	13.6-16.5	13.9-18.2
Mangaoraka Stream	NA	18.0
Mangati Stream	NA	16.0-17.0
Mangawhero Stream	13.8-14.0	17.5-17.6
Mangorei Stream	NA	17.4
Patea River	9.9-15.9	11.3-16.1
Punehu Stream	14.8-14.8	14.7-15.6
Tangahoe River	15.0-15.4	14.2-14.8
Timaru Stream	NA	14.1-16.0
Waiau Stream	NA	18.1
Waimoku Stream	NA	14.1-16.5
Waingongoro River	7.9-16.8	13.0-21.1
Waiokura Stream	12.7-13.4	13.4-16.8
Waiongana Stream	NA	15.5-17.43
Waitara River	NR	20.0-20.1
Waiwhakaiho River	NA	13.2-17.2
Whenuakura River	16.7	17.2

NA: not assessed due to high flows, N/R = not recorded

Water temperatures ranged from 9.9˚C to 21.1˚C (Table 4) with higher altitude sites typically recording lower temperatures than lower altitude sites, and spring temperatures (9.9°C to 16.8°C) typically recording lower temperatures than summer temperatures (10.8°C to 21.1°C) (Table 4). These ranges tended to be typical of most past surveys.

Hydrological flow recorders continuously monitor water levels in the Mangaoraka, Waiongana, Punehu, and Kapoaiaia Streams, and the Waiwhakaiho, Manganui, Patea, Mangaehu, Waingongoro, Kaupokonui, Waitara and Whenuakura Rivers. The proximity of previous freshes (elevated flows) for each site surveyed, are summarised in Table 5, with flow assessments extrapolated from nearby catchments for sites where flow recorders did not exist.

Table 5 Duration since freshes at sampling sites in the 2016-2017 SEM biomonitoring programme

River/stream	Site	Spring survey (days after flow above)		Summer survey (days after flow above)	
		3 x median	7 x median	3 x median	7 x median
Hangatahua (Stony) R	Mangatete Road	(NA)	(NA)	(22)	(26)
Hangatahua (Stony) R	SH45	(NA)	(NA)	(22)	(26)
Herekawe S	Centennial Drive	(NA)	(NA)	(11)	(13)
Huatoki S	Hadley Drive	(NA)	(NA)	(11)	(13)
Huatoki S	Huatoki Domain	(NA)	(NA)	(11)	(13)
Huatoki S	Molesworth St	(NA)	(NA)	(19)	(19)
Kapoaiaia S	Wiremu Road	16	16	28	28
Kapoaiaia S	Wataroa Road	16	16	28	28
Kapoaiaia S	Near coast	16	16	28	28
Katikara S	Carrington Road	(NA)	(NA)	(9)	(13)
Katikara S	Near mouth	(NA)	(NA)	(9)	(13)
Kaupokonui R	Opunake Rd	12	31	18	18
Kaupokonui R	U/s Kaponga oxi ponds	12	31	18	18
Kaupokonui R	U/s Lactose Co.	12	31	18	18
Kaupokonui R	Glenn Rd	12	31	18	18
Kaupokonui R	Beach	12	31	18	18
Kurapete S	U/s Inglewood WWTP	(NA)	(NA)	(18)	(18)
Kurapete S	6 km d/s Inglewood WWTP	(NA)	(NA)	(18)	(18)
Maketawa S	Opp Derby Road	(NA)	(NA)	(28)	(28)
Maketawa S	Tarata Road	(NA)	(NA)	(28)	(28)
Mangaehu R	Raupuha Road	8	103	16	16
Manganui R	SH3	7	12	19	20
Manganui R	Bristol Road	7	12	19	20
Mangaoraka S	Corbett Road	(NA)	(NA)	7	42
Mangati S	D/s railway line	(NA)	(NA)	(10)	(28)
Mangati S	Te Rima Pl, Bell Block	(NA)	(NA)	(10)	(28)
Mangawhero S	U/s Eltham WWT Plant	(9)	(16)	(94)	(191)
Mangawhero S	D/s Mangawharawhara S	(9)	(16)	(94)	(191)
Mangorei S	SH3	(NA)	(NA)	(10)	(10)
Patea R	Barclay Rd	8	23	9	10
Patea R	Swansea Rd	8	23	9	10
Patea R	Skinner Rd	8	23	9	10
Punehu S	Wiremu Rd	10	10	32	33
Punehu S	SH45	10	10	32	33
Tangahoe R	Upper Valley	(32)	(75)	(7)	(29)
Tangahoe R	Tangahoe Valley Road	(32)	(75)	(7)	(29)
Tangahoe R	D/s railbridge	(32)	(75)	(7)	(29)
Timaru S	Carrington Road	(NA)	(NA)	(11)	(11)
Timaru S	SH45	(NA)	(NA)	(11)	(11)

River/stream	Site	Spring survey (days after flow above)		Summer survey (days after flow above)	
		3 x median	7 x median	3 x median	7 x median
Waiau S	Inland North Road	(NA)	(NA)	(10)	(12)
Waimoku S	Lucy's Gully	(NA)	(NA)	(11)	(11)
Waimoku S	Beach	(NA)	(NA)	(11)	(11)
Waingongoro R	900m d/s Nat Park	9	16	22	23
Waingongoro R	Opunake Rd	9	16	22	23
Waingongoro R	Eltham Rd	9	16	22	23
Waingongoro R	Stuart Rd	16	30	23	90
Waingongoro R	SH45	16	30	23	90
Waingongoro R	Ohawe Beach	14	26	12	12
Waiokura S	Skeet Road	(73)	(74)	(18)	(18)
Waiokura S	Manaia Golf-Course	(73)	(74)	(18)	(18)
Waiongana S	SH3a	(NA)	(NA)	11	12
Waiongana S	Devon Road	(NA)	(NA)	11	12
Waitara	Autawa Road	12	21	9	10
Waitara	Mamaku Road	10	11	10	10
Waiwhakaiho R	National Park	(NA)	(NA)	12	12
Waiwhakaiho R	SH3 (Egmont Village)	(NA)	(NA)	12	12
Waiwhakaiho R	Constance St (NP)	(NA)	(NA)	12	12
Waiwhakaiho R	Adjacent Lake Rotomanu	(NA)	(NA)	12	12
Whenuakura R	Nicholson Road	26	35	7	29

NB: ( ) = extrapolation from nearby catchment, NA: not assessed due to high flows

The spring 2016 surveys were undertaken during a very wet period with surveys undertaken from October to January. Twenty-seven of the 59 sites in spring were not sampled due to persistently high flows. Flow protocols prevent sampling within seven days after a 3x median fresh or ten days after a 7x median fresh, as higher flows disturb community composition and abundance. Spring surveys were conducted 7 to 32 days after a moderate fresh (> 3x median flow). The summer 2016 surveys were conducted over February and March. Rivers and streams had relatively low flows due to the drier conditions which was normal for summer conditions. Surveys were performed 7-94 days after a moderate fresh.

3.2 Macroinvertebrate communities

Lists of the taxa found during spring 2016 and summer 2017 surveys, together with taxa richness, MCI scores and other appropriate indices for each site are tabulated and attached as Appendix I. These results are discussed below on a stream by stream basis for the sites and seasons (spring and summer) in which the surveys were conducted. Data from previous surveys are also presented for each site and results to date are illustrated as appropriate.

3.2.1 Hangatahua (Stony) River

The Hangatahua (Stony) River is a ringplain river whose source is located within Egmont National Park. The lower part of the river has a very narrow catchment and generally good water quality. There are two sites monitored for SEM purposes on the Hangatahua (Stony) River.

In the winter of 1996 a massive drift of sand moved down the Hangatahua River and devastated macroinvertebrate communities, following a major erosion event in the headwaters of the river. Few macroinvertebrate taxa were found in the river in the spring of 1996 (Figure 2 and Figure 4). Since then sand has continued to affect the macroinvertebrate communities of the river, although some recovery was observed in the communities in March and November 1997, January and February 1999, late 2000, and again in 2002-2003. At these times greater numbers and varieties of macroinvertebrates were recorded on the riverbed. The very high MCI score of 160 recorded at SH45 in November 1998 (Figure 2) was the result of a community consisting of only one taxon (and just a single individual) which was highly sensitive to pollution. The MCI is not a good indicator of water quality when only a small number of taxa are present and is not typically the index used to assess the impacts of sedimentation in stony streams. However, the MCI has some value in the assessment of recovery of the faunal community with time and has some value in trend evaluation.

A further massive sand drift moved down the river following very heavy February 2004 rainfall and significant flood flows in late February, some three weeks prior to the summer 2004 survey. An additional survey was performed in late winter 2004 to document the continuing effects of sand/sediment drift (see Figures 2 and 3), some three months prior to the late spring survey. Further erosion effects occurred in late 2006 delaying the spring 2006 survey and during the latter months of 2007 while significant sand and scoria bed scouring and sedimentation occurred down the river in mid year and again in spring 2008 delaying the 'spring' survey until early in 2009. No large-scale significant headwater erosion events were recorded between spring 2009 and summer 2014 but there was a headwater erosion event in February 2014. There have been no major headwater erosion events since February 2014 though minor bed scouring and sedimentation effects continued to impact during the 2016-2018 period. Due to persistently high flows no spring 2016 survey was able to be performed. The results of the summer 2017 survey are presented in Table 130, Appendix I.

3.2.1.1 Mangatete Road site (STY000300)

3.2.1.1.1 Taxa richness and MCI

Forty-four SEM surveys have been undertaken in the Stony River at this mid-reach site between October 1995 and February 2016. These results are summarised in Table 6, together with results from the current period, and illustrated in Figure 2.

Table 6 Results from SEM surveys performed in the Stony River at Mangatete Road together with summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI
STY000300	44	1-21	10	64-160	112	3	107

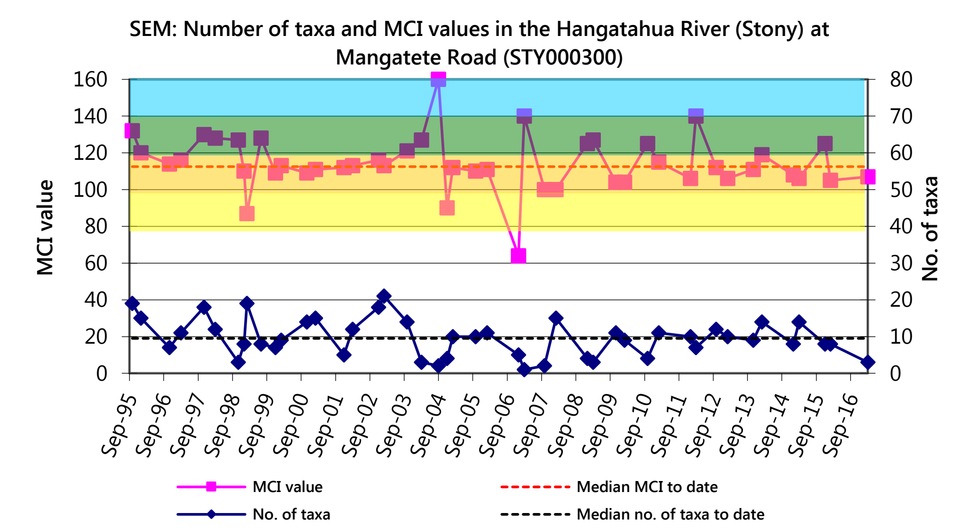


Figure 2 Numbers of taxa and MCI values in the Hangatahua (Stony) River at Mangatete Road

A wide range of richnesses (1 to 21 taxa) has been recorded as a consequence of extensive headwater erosion impacts on the river's communities with a median richness of only 10 taxa, far fewer than might be expected for a ringplain river site at this altitude (160 masl). In the 2016-2017 period, richness was much lower than the median, indicative of continuing erosion impacts of scouring, finer sediment deposition, and bed movement. Erosion was exasperated by the very wet period causing significant freshes preceding the summer survey.

There are significant limitations when using the MCI for community compositions affected by sedimentation and erosion events (e.g. scores show considerable significant variability when relatively few taxa are present). Values at this site have ranged widely between 64 and 160 units with a median MCI value of 112 units. The summer score was a non-significant five units lower than the historical median. The summer score categorised this site as having 'good' health (Table 2). The historical median score (112 units) placed this site's river health in the 'good' category. The paucity of the communities in terms of richnesses in particular must be taken into account at the site, where headwater erosion effects have been very pronounced and the substrate remains relatively mobile and well scoured.

3.2.1.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 7.

Table 7 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Stony River at Mangatete Road between 1995 and February 2016 [44 surveys] and by the summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Surveys Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	1			1	2	
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	10	15	9	34	76	
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	14	1		15	33	
COLEOPTERA (BEETLES)	Elmidae	6	12	2		14	31	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	4			4	9	

Taxa List		MCI score	A	VA	XA	Total	%	Surveys Summer 2017
	Costachorema	7	5			5	11	
	Hydrobiosis	5	1			1	2	
	Oxyethira	2	1			1	2	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	1			1	2	
	Eriopterini	5	4			4	9	
	Maoridiamesa	3	2	1		3	7	
	Orthocladiinae	2	6	1		7	16	

Prior to the current 2016-2017 period, twelve taxa have characterised this site's communities on survey occasions. These have comprised two 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa. The 'highly sensitive' ubiquitous mayfly (*Deleatidium*) has occurred in over 50% of samples. This taxon and elmid beetles are often present (frequently in large numbers) on unstable shingle-cobble substrates (Death, 2000). No characteristic taxa were dominant in the summer community. These results were indicative of the significant reduction in diversity of characteristic taxa due to headwater erosion impacts, unstable substrate and significant number of freshes preceding the survey. The lack of abundances of midge taxa on both occasions was coincident with the presence of minimal periphyton mats cover on the cobble-boulder substrate; an indication of the instability of the substrate and limited recovery from scouring/erosion events.

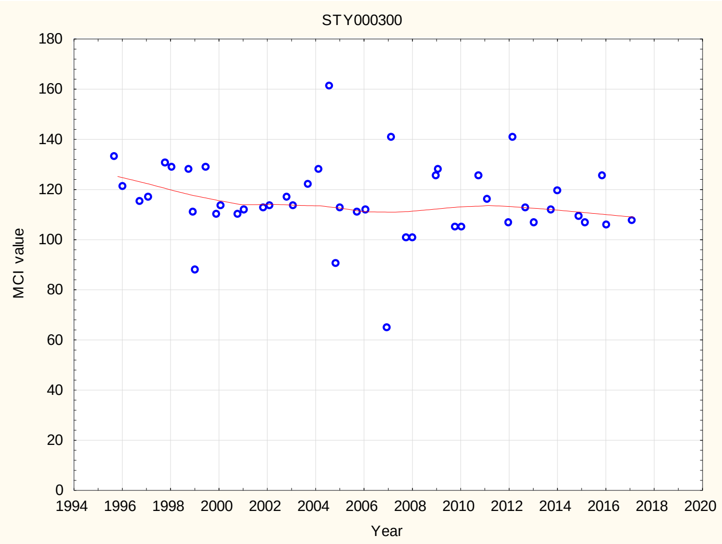
3.2.1.1.3 Predicted river 'health'

The Stony River at Mangatete Road is 7.3 km downstream of the National Park boundary at an altitude of 160 masl. A relationship for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 109 for this site. The historical site median (112 units) was not significantly different (Stark and Fowles, 2009) to the predictive value. The summer 2017 survey score was also not significantly different to the predictive value.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 108 units. The historical site median (112 units) was not significantly different to this value. The summer score was also not significantly different. The REC predicted MCI value (Leathwick, et al. 2009) was 128 units. The historical site median and the summer score were both significantly lower than this value.

3.2.1.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 3). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Stony River at Mangatete Road.



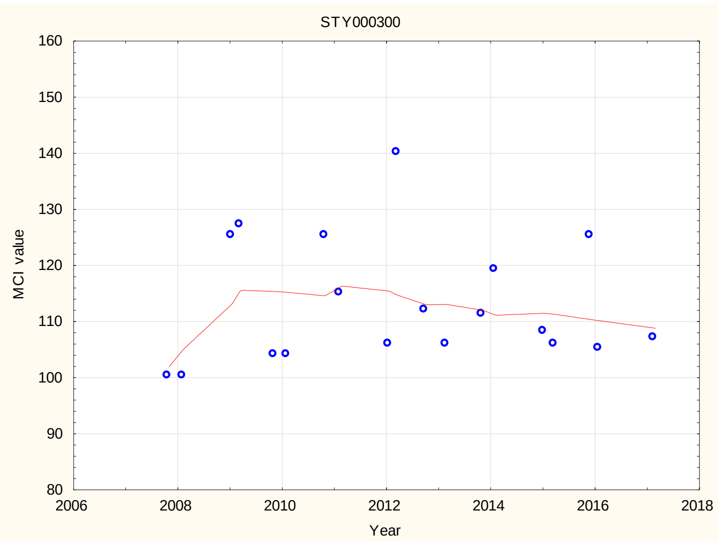
N = 46
Kendall tau = - 0.191
p level = 0.060
FDR p = 0.101

Figure 3 LOWESS trend plot of MCI data at Mangatete Road site

Although a decreasing trend in MCI scores has been found, particularly over the first six years, this has not been statistically significant. The trendline at this site has a range of MCI scores of about 16 units indicative of some important ecological variability over the period, not surprisingly given the erosion effect documented earlier and further emphasised by the wide range of individual scores, particularly since 2004. Overall, the trendline shows 'good' generic river 'health' (Table 2); deteriorating slightly from 'very good' (prior to 1999). However, the majority of the variability was caused by severe headwater erosion events at varying intervals over the period.

3.2.1.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 4). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Stony River at Mangatete Road.



N = 19
Kendall tau = 0.078
p level = 0.641
FDR p = 0.835

Figure 4 Ten year LOWESS trend plot of ten years of MCI data at Mangatete Road site

Overall, a slight increasing trend in MCI scores has been found at this site, particularly evident over the first three years. Hoever, this has not been statistically significant. Overall, the trend line shows 'good' generic river 'health' (Table 2).

3.2.1.2 SH 45 site (STY000400)

3.2.1.2.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Stony River at this lower reach site between October 1995 and February 2016. These results are summarised in Table 8, together with results from the current period, and illustrated in Figure 5.

Table 8 Results from SEM surveys performed in the Stony River at SH 45 together with summer 2017 result

Site code	SEM data (1995 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI
STY000400	44	0-18	9	0-160	109	6	100

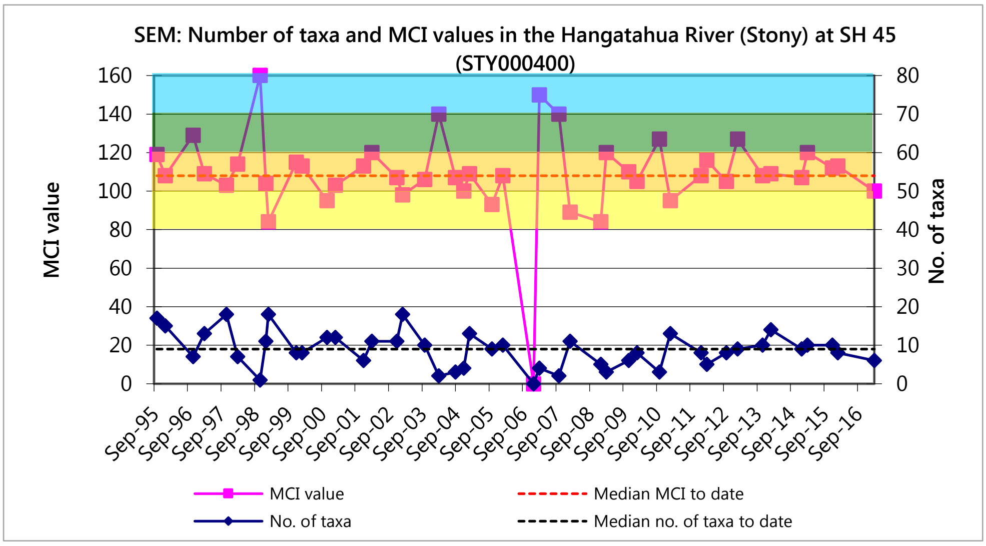


Figure 5 Numbers of taxa and MCI values in the Hangatahua (Stony) River at SH 45

A wide range of richnesses (0 to 18 taxa) has been recorded mainly as a consequence of extensive headwater erosion impacts on the river's communities, with a median richness of only nine taxa, far fewer than would be expected for a ringplain river site at this altitude (70 m asl) [e.g. median of 18 taxa (TRC, 2016b)]. In the 2016-2017 period richness was low with only six taxa recorded and three taxa lower than the site's historical median, indicative of continuing erosion impacts of scouring, finer sediment deposition, and bed movement at this site.

There are significant limitations when using the MCI for community compositions affected by sedimentation and erosion events (e.g. scores show considerable variability when relatively few taxa are present). Values at this site have ranged widely between 0 and 160 units with a median MCI value of 109 units. The MCI score for the summer 2017 survey (100 units) was a non-significant nine units lower than the historical median (Figure 5). The score categorised this site as having 'good' health (Table 2). However, the paucity of numbers and richnesses should be recognised in this assessment given the historical impacts of headwater erosion effects along the length of the river channel and the persistently high rainfall that occurred preceding this survey.

3.2.1.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 9.

Table 9 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Stony River at SH 45 between 1995 and February 2015 [44 surveys] and by the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Surveys
								Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	1			1	2	
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	10	13	10	33	73	A
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	9			9	20	
COLEOPTERA (BEETLES)	Elmidae	6	7			7	16	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	7			7	16	
	Costachorema	7	4	1		5	11	
	Hydrobiosis	5	4			4	9	
	Oxyethira	2	1			1	2	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	1			1	2	
	Eriopterini	5	1			1	2	
	Maoridiamesa	3	1	2		3	7	
	Orthocladiinae	2	8	2		10	22	

Prior to the current 2016-2017 period, twelve taxa have characterised this site's communities on survey occasions. These have been comprised of two 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa. The 'highly sensitive' ubiquitous mayfly (*Deleatidium*) has occurred in over 50% of samples. This taxon is often present on unstable shingle-cobble substrates (Death, 2000). Only one taxon was abundant during the summer survey. The result was indicative of a paucity of characteristic taxa due to preceding headwater erosion impacts and/or substrate instability. The relative paucity of midge taxa recorded in both seasons was consistent with only thin periphyton mat layers on the mobile cobble-boulder substrate.

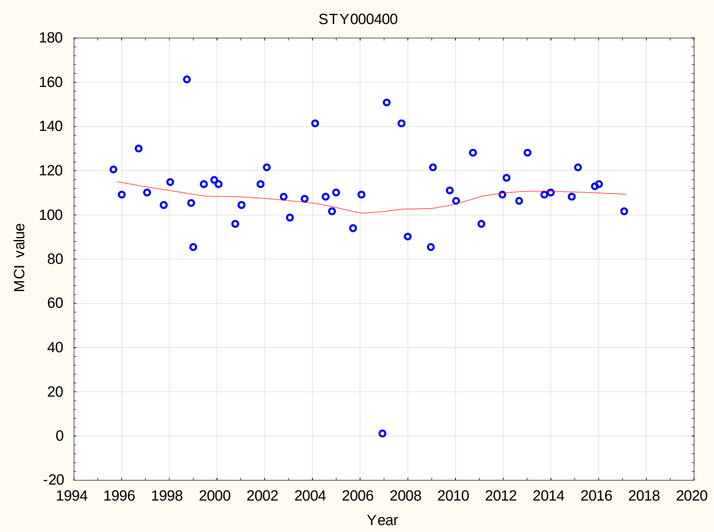
3.2.1.2.3 Predicted river 'health'

The Stony River at SH 45 is 12.5 km downstream of the National Park boundary at an altitude of 70 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict an MCI value of 103 for this site. The historical site median and summer score were both not significantly different (Stark, 1998) to the distance predictive value.

The historical median score (109 units) was significantly higher than other ringplain streams of similar altitude arising within the National Park (98 units) (TRC, 2016b). The summer score was not significantly different. The historical median was not significantly different to the REC predicted score (Leathwick, et al. 2009) of 115 units but the summer score was significantly lower.

3.2.1.2.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 6). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Stony River at SH 45.



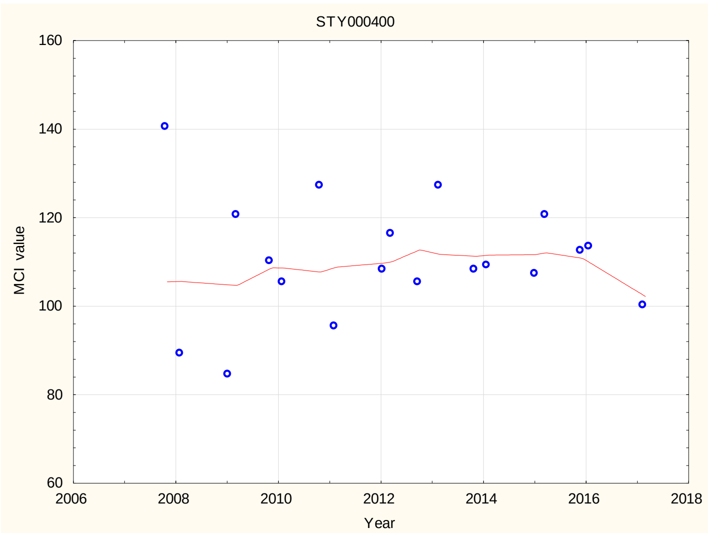
N = 46
Kendall tau = - 0.028
p level = 0.781
FDR p = 0.836

Figure 6 LOWESS trend plot of MCI data at SH 45 site

An overall slightly decreasing trend in MCI scores over the period has not been statistically significant. The trendline at the site has a MCI range of about 16 units indicative of some important ecological variability over the period for the same reasons as those responsible for variability at the upstream site (Mangatete Rd). This was a similar trend to that found at the upstream mid-reach (Mangatete Road) site. Greater variability in scores has been apparent since 2004 with the majority of the variability in MCI scores associated with headwater erosion events. Overall, the trendline shows 'good' generic river 'health' (Table 2).

3.2.1.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Table 7). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Stony River at SH 45.



N = 19
Kendall tau = 0041
p level = 0.804
FDR p = 0.919

Figure 7 LOWESS trend plot of ten years of MCI data at SH 45 site

There has been a minor positive trend in MCI scores over the period which was not statistically significant. Overall the trend line shows 'good' generic river 'health' (Table 2).

3.2.1.3 Discussion

Due to the major influence of historic and relatively frequent headwater erosion events, scouring, and instability of the river bed; seasonal and spatial differences in macroinvertebrate communities in the Stony River often have not been as pronounced as elsewhere in ringplain streams. No spring survey was able to be completed due to persistently high flows.

Taxa richnesses at both sites, but especially the upper site, were very low both in terms of total numbers and relative to historic medians. This was likely due to erosion events and significant freshes preceding the survey impacting on the macroinvertebrate communities.

MCI scores indicted 'good' health for both sites which were not significantly different to historic medians. There was a non-significant decrease in MCI score at the downstream site of seven units under summer conditions. However, there was a significance decrease in $SQMCI_s$ score by 1.6 units between the two sites at the time of the survey suggestive of some nutrient enrichment at the downstream site but a lack of diversity and animal abundances at both sites would have impacted $SQMCI_s$ scores.

3.2.2 Herekawe Stream

One site in this small lowland coastal ringplain stream on the western perimeter of New Plymouth City was incorporated into the SEM programme in 2008 for the purpose of monitoring a newly-developed walkway and associated riparian planting initiatives in the lower reaches of the stream. Consent monitoring also has been performed at this 'control' site in spring and summer throughout the period from 1995 to 2017 (and dates back to 1986). Due to persistently high flows no spring 2016 survey was able to be performed.

The results found by the 2016-2017 summer survey are presented in Table 131, Appendix I for this small lowland stream.

3.2.2.1 Centennial Drive site (HRK000085)

3.2.2.1.1 Taxa richness and MCI

Forty-three surveys have been undertaken in this lower-reach site in the Herekawe Stream between February 1995 and February 2016. These results are summarised in Table 10, together with the results from the current period, and illustrated in Figure 8.

Table 10 Results of previous surveys performed in Herekawe Stream at Centennial Drive, together with summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI
HRK000085	43	13-23	18	68-100	89	15	97

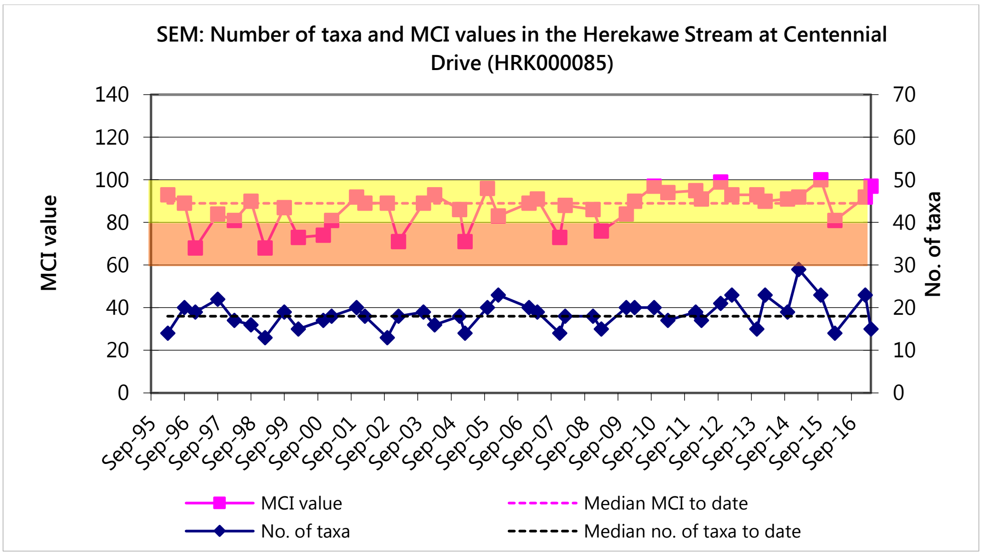


Figure 8 Numbers of taxa and MCI values in the Herekawe Stream upstream of Centennial Drive

A moderate range of richnesses (13 to 23 taxa) had been found, with a median richness of 18 taxa which has been more representative of typical richnesses in small lowland coastal streams where a median richness of 17 taxa has been recorded from previous surveys of 'control' sites at similar altitudes (TRC, 2016b). During the 2016-2017 period, summer (15 taxa) richness was similar to the median richness for the site. MCI values have had a relatively wide range (31 units) at this site. The median value (89 units) is above scores typical of lower reach sites elsewhere in small lowland coastal streams. The summer 2017 (97 units) score was not significantly different (Stark, 1998) to the historical median. These scores categorised this site as having 'fair' health generically (Table 2). The historical median score (89 units) placed this site in the 'fair' category.

3.2.2.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 11.

Table 11 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Herekawe Stream at Centennial Drive between 1998 and February 2016 [43 surveys], and summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	24	4	2	30	73	
MOLLUSCA	*Potamopyrgus*	4	7	17	17	41	100	XA
CRUSTACEA	Ostracoda	1	2			2	5	
	Paracalliope	5	18	9	8	35	85	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	3			3	7	
	Coloburiscus	7	5			5	12	
PLECOPTERA (STONEFLIES)	*Acroperla*	5	1			1	2	
	Megaleptoperla	9	1			1	2	
COLEOPTERA (BEETLES)	Elmidae	6		1		1	2	VA

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
TRICHOPTERA (CADDISFLIES)	*Oxyethira*	2	9	2		11	27	
	Triplectides	5	12	1		13	32	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	2			2	5	
	Orthocladiinae	2	17	7		24	59	
	Austrosimulium	3	12	1	1	14	34	

Prior to the current 2016-2017 period, 14 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive taxon, seven 'moderately sensitive' and six 'tolerant' taxa i.e. a relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a small, lowland coastal stream. Characteristic taxa abundant for over 50% of the surveys include one 'moderately sensitive' taxon [amphipod (*Paracalliope*)] and three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges]. The summer 2017 community was characterised by four taxa.

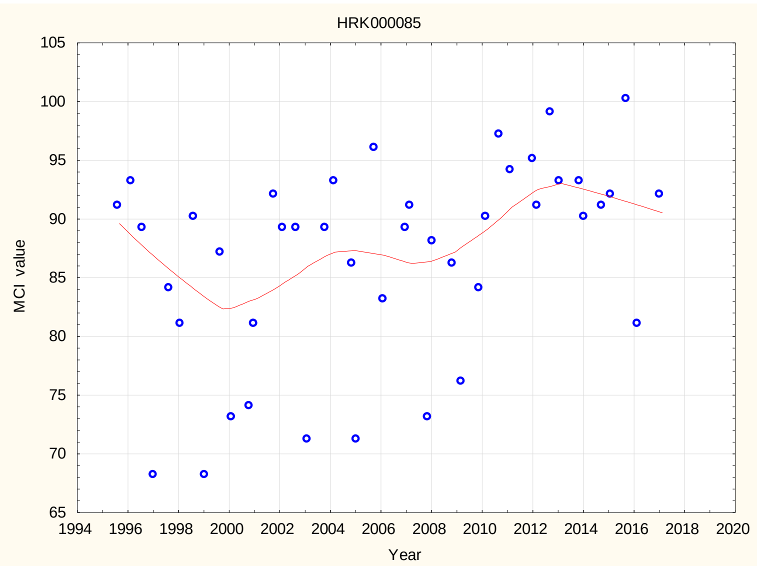
3.2.2.1.3 Predicted stream 'health'

The Herekawe Stream rises as seepage near the coast on the ringplain and the site at Centennial Drive, Omata is in the lower reaches near the mouth at an altitude of 5 m asl.

The median MCI score for a lowland coastal stream at similar altitude was 79 units (TRC, 2016b). The historical median MCI was an insignificant 10 units higher than this median. However, the summer score was significantly higher than this median by 18 units. The REC predicted MCI value (Leathwick, et al. 2009) was 89 units. The historical median and summer score and were both not significantly different (Stark, 1998) to this value.

3.2.2.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 9). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on 22 years of SEM results (1995-2017) from Herekawe Stream at Centennial Drive.



N = 43
Kendall tau = +0.302
p level = 0.004
FDR p = 0.010

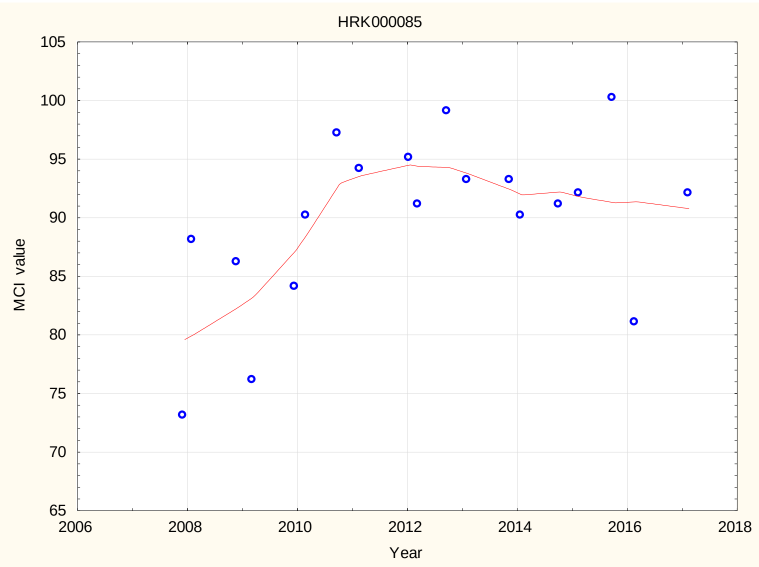
Figure 9 LOWESS trend plot of MCI data in the Herekawe Stream at the Centennial Drive site

The positive trend in MCI scores was significant (FDR p < 0.05) at this site in the lower reaches of the stream immediately downstream of the more recently constructed walkway. Trends have varied at this site over the 22-year period with a general trend of improvement since 2000 and particularly after 2008, with more recent stability, but with some wide variations in individual MCI scores. The trendline variation (12 units) suggested some ecologically important changes have occurred over the monitoring period.

The trendline was indicative of 'fair' stream health until 2010, since when the trendline has indicated 'good' stream health.

3.2.2.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 10). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the ten most recent years of SEM results (2007-2017) from Herekawe Stream at Centennial Drive.



N = 19
Kendall tau = +0.290
p level = 0.083
FDR p = 0.381

Figure 10 LOWESS trend plot of ten years of MCI data in the Herekawe Stream at the Centennial Drive site

A positive non-significant trend in MCI scores has been found over the ten year period in contrast with the significant positive result found in the full dataset. The ten year dataset trend shows an increase from 2008 to 2012 but overall the trendline change was negligible. The trendline was indicative of 'fair' health (Table 2).

3.2.2.2 Discussion

Due to persistently high flows no spring 2016 survey was able to be performed and therefore no comparison between spring and summer surveys can be made. Spring and summer values are typically very similar at this site with seasonal median MCI values being identical over the twenty-two year period (Appendix II). The summer survey results were within expected parameters with the site having 'fair' health and not having any significant differences between the current score and median and predicted results.

3.2.3 Huatoki Stream

The Huatoki Stream is a small ringplain stream arising outside Egmont National Park that flows south to north with the middle and lower parts of the catchment in the New Plymouth city area. There are three SEM sites on the stream. Due to persistently high flows no spring 2016 survey was able to be performed. The results of summer 2017 survey are summarised in Table 132, Appendix I.

3.2.3.1 Hadley Drive site (HTK000350)

3.2.3.1.1 Taxa richness and MCI

Forty surveys have been undertaken, between December 1996 and February 2016, at this lower mid-reach, unshaded site, draining open developed farmland, on the outskirts of New Plymouth city. These results are summarised in Table 12, together with the results from the current period, and illustrated in Figure 11.

Table 12 Results of previous surveys performed in the Huatoki Stream at Hadley Drive together with summer 2017 result

Site code	SEM data (1996 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
HTK000350	40	22-34	26	79-115	96	24	110

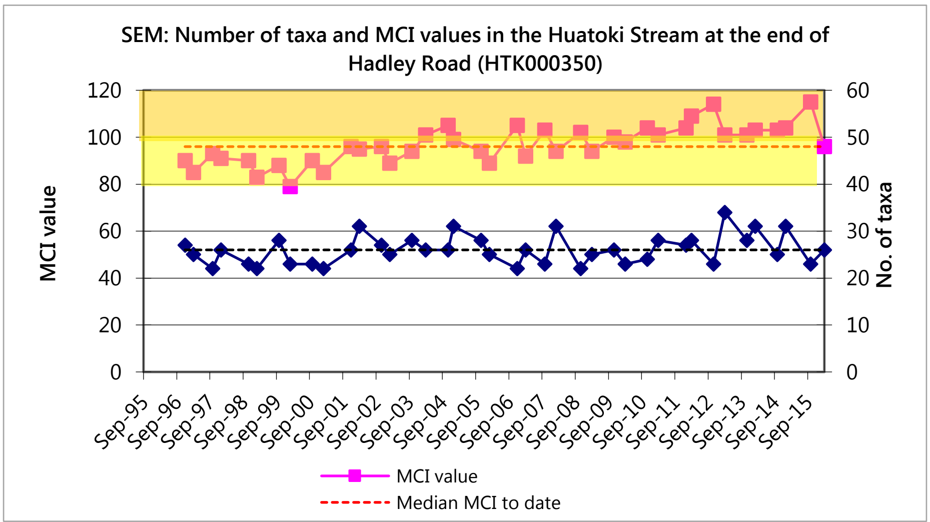


Figure 11 Numbers of taxa and MCI values in the Huatoki Stream at the end of Hadley Drive

A moderate range of richnesses (22 to 34 taxa) has been found with a relatively high median richness of 26 taxa, relatively typical of richnesses in the mid to lower reaches of ringplain streams rising outside of the National Park. During the 2016-2017 period summer (24 taxa) richness was relatively similar to the historical median richness.

MCI values have had a relatively wide range (36 units) at this site, typical of mid to lower reach sites on the ringplain. The summer 2017 (110 units) score was significantly higher (Stark, 1998) than the historical median by 14 units. The score categorised this site as having 'good' health generically (Table 2). The historical median score (96 units) placed this site in the 'fair' category for generic health.

3.2.3.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 13.

Table 13 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Huatoki Stream at Hadley Drive, between 1996 and February 2016 [40 surveys], and summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
NEMERTEA	Nemertea	3	3			3	8	
ANNELIDA (WORMS)	Oligochaeta	1	21	4		25	63	
MOLLUSCA	*Latia*	5	4			4	10	
	Potamopyrgus	4	16	7		23	58	
CRUSTACEA	*Paracalliope*	5	6			6	15	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	13	2		15	38	
	Coloburiscus	7	8	14	3	25	63	VA
	Deleatidium	8	2	5	4	11	28	VA
	Nesameletus	9	10	5	1	16	40	VA
	Zephlebia group	7	17	9		26	65	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	10	2		12	30	
	Zelandoperla	8	1			1	3	
COLEOPTERA (BEETLES)	Elmidae	6	4	14		18	45	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	8			8	20	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	11	21	7	39	98	VA
	Costachorema	7	22			22	55	
	Hydrobiosis	5	22	2	1	25	63	
	Neurochorema	6	3			3	8	
	Oxyethira	2	3	1		4	10	
	Pycnocentrodes	5	5			5	13	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	13	5		18	45	A
	Maoridiamesa	3	13	6	1	20	50	
	Orthocladiinae	2	12	14	10	36	90	
	Tanytarsini	3	7	8	1	16	40	
	Empididae	3	1			1	3	
	Muscidae	3	5			5	13	
	Austrosimulium	3	14	3		17	43	

Prior to the current 2016-2017 period 27 taxa had characterised the community at this site on occasions. These have comprised only three 'highly sensitive' taxa, 13 'moderately sensitive' and 11 'tolerant' taxa i.e. a relatively high proportion of 'tolerant' taxa as would be expected in the lower mid-reaches of a ringplain stream rising outside the National Park.

Taxa that were characteristic taxa over 50% of the time included five 'moderately sensitive' taxa [mayflies (*Coloburiscus* and *Zephlebia* group), free-living caddisflies (*Hydrobiosis* and *Costachorema*), and cranefly (*Aphrophila*)]; and five 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)]. The summer 2017 survey comprised seven characteristic taxa that were mostly ‘sensitive’ to nutrient enrichment which reflected the high $SQMCI_s$ score of 6.6 units which indicated ‘very good’ health.

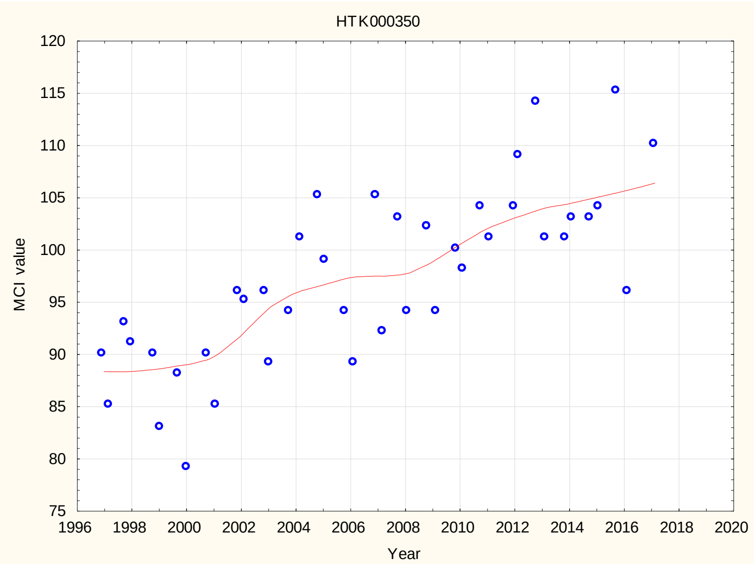
3.2.3.1.3 Predicted stream ‘health’

The Huatoki Stream rises below the National Park boundary and the site at Hadley Drive is in the lower mid-reaches at an altitude of 60 m asl.

The median value for a ringplain stream arising outside the National Park (TRC, 2016b) was 95 units. The historical score was very similar to this value and the summer score was significantly higher (Stark, 1998) by 15 units different to the value. The REC predicted MCI value (Leathwick, et al. 2009) was 93 units. The historical score was similar to this value and the summer score was significantly higher (Stark, 1998) by 17 units.

3.2.3.1.4 Temporal trends in 1996 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 12). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 20 years of SEM results (1996-2017) from the site in the Huatoki Stream at Hadley Drive. The MCI has been chosen as the preferable indicator of ‘stream/river health’ for SEM trend reporting purposes.



N = 41
Kendall tau = +0.569
p level <0.001
FDR p < 0.001

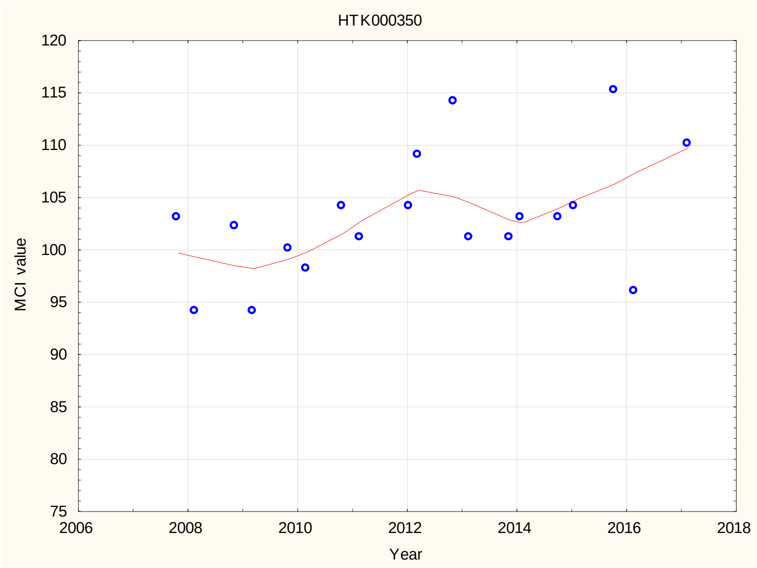
Figure 12 LOWESS trend plot of MCI data in the Huatoki Stream at the Hadley Drive site

A strong significant improvement (p< 0.01) in MCI scores, particularly since 2000 has been illustrated at this site on the outskirts of New Plymouth. The wide LOWESS-smoothed range of MCI scores (15 units) has ecological importance and may have been related to improvements in farming practices (including more recent riparian fencing) and/or wastes disposal in the rural catchment between the stream’s seepage sources (below the National Park) and urban New Plymouth.

LOWESS-smoothed MCI scores have been indicative of ‘fair’ generic stream health (Table 2) almost throughout the period improving to ‘good’ health since 2010.

3.2.3.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 13). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Huatoki Stream at Hadley Drive.



N = 19
Kendall tau = +0.356
p level = 0.033
FDR p = 0.265

Figure 13 LOWESS trend plot of ten years of MCI data in the Huatoki Stream at the Hadley Drive site

A minor positive non-significant result was found in contrast with the full dataset which had a significant positive result. Only minor variation in the trendline was evident for the ten year period suggesting little real change. The trendline was indicative of mostly 'good' generic stream health (Table 2).

3.2.3.2 Huatoki Domain site (HTK000425)

3.2.3.2.1 Taxa richness and MCI

Forty surveys have been undertaken at this lower middle reach site in the Huatoki Stream toward the downstream boundary of the Huatoki Domain between December 1996 and February 2016. These results are summarised in Table 14, together with the results from the current period, and illustrated in Figure 14.

Table 14 Results of previous surveys performed at Huatoki Stream in Huatoki Domain, together with the summer 2017 result

Site code	SEM data (1996 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
HTK000425	40	17-32	26	91-115	104	21	109

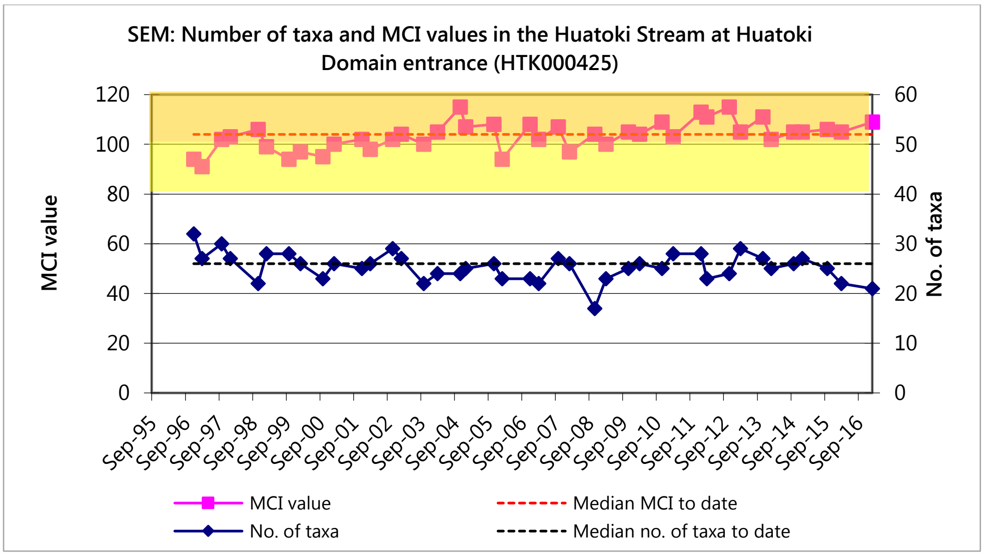


Figure 14 Numbers of taxa and MCI values in the Huatoki Stream at the Huatoki Domain

A moderate range of richnesses (17 to 32 taxa) has been found, with a median richness of 26 taxa (more representative of typical richnesses for the lower reaches of ringplain streams rising outside the National Park boundary). During the 2016-2017 period summer (21 taxa) richness was five taxa lower than the historic median richness.

MCI values have had a moderately wide range (24 units) at this site. The median value (104 units) has been higher than typical of lower reach sites elsewhere on the ringplain however. The summer 2017 (109 units) score was not significantly different to the historic median value. The score categorised this site as having 'good' health generically (Table 2). The historical median score (104 units) also placed this site in the 'good' category for generic health.

3.2.3.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 15.

Table 15 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Huatoki Stream at Huatoki Domain, between 1996 and February 2016 [40 surveys], and summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
NEMERTEA	Nemertea	3	3			3	8	
ANNELIDA (WORMS)	Oligochaeta	1	29	4		33	83	
MOLLUSCA	*Latia*	5	15			15	38	
	Potamopyrgus	4	20	12	2	34	85	
CRUSTACEA	*Paracalliope*	5	3			3	8	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	9	5		14	35	A
	Coloburiscus	7	8	18	9	35	88	VA
	Deleatidium	8	4	8		12	30	VA
	Mauiulus	5	1			1	3	

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
	Nesameletus	9	1			1	3	
	Zephlebia group	7	23	9	2	34	85	
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	10	9		19	48	
COLEOPTERA (BEETLES)	Elmidae	6	10	17	2	29	73	VA
	Ptilodactylidae	8	3			3	8	
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	19	1		20	50	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	18	18	3	39	98	VA
	Costachorema	7	1			1	3	
	Hydrobiosis	5	8			8	20	
	Pycnocentria	7	2			2	5	
	Pycnocentrodes	5	20	3		23	58	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	1			1	3	
	Orthocladiinae	2	12			12	30	
	Polypedilum	3	1			1	3	
	Austrosimulium	3	27	8	1	36	90	A
	Tanyderidae	4	1			1	3	

Prior to the current 2016-2017 period, 25 taxa had characterised the community at this site on occasions. These have comprised three 'highly sensitive', 14 'moderately sensitive', and eight 'tolerant' taxa i.e. a higher proportion of 'sensitive' taxa than might be expected in the lower reaches of a ringplain stream, coincident with the extensive riparian cover provided by the Huatoki Domain. Predominant taxa have included no 'highly sensitive' taxa; four 'moderately sensitive' taxa [mayflies (*Zephlebia* group and *Coloburiscus*), elmid beetles, and stony-cased caddisfly (*Pycnocentrodes*)]; and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and sandfly (*Austrosimulium*)]. The summer 2017 community consisted of nine historically characteristic taxa comprising one 'highly sensitive', seven 'moderately sensitive', and one 'tolerant' taxa. The summer 2017 community consisted of seven historically characteristic taxa which were mostly 'sensitive' species which was reflected in the high SQMCIs score of 6.5 units indicating 'very good' health (Table 15)(Table 132).

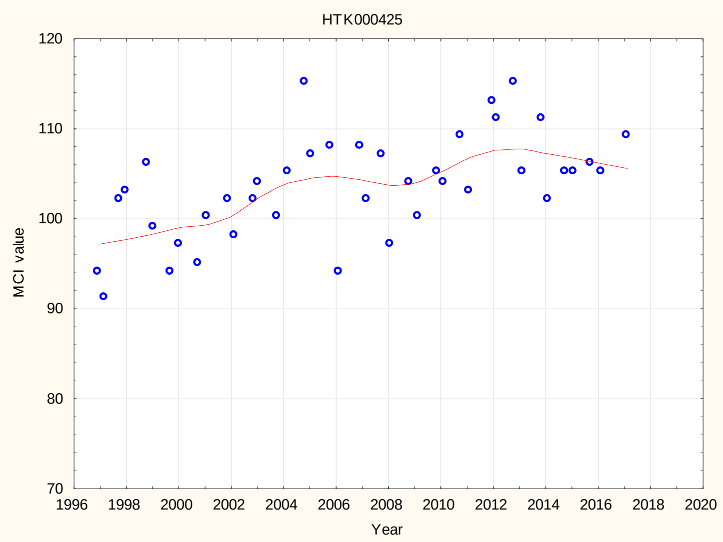
3.2.3.2.3 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site at Hadley Domain is in the lower mid-reaches at an altitude of 30 m asl.

The median value for a ringplain stream arising outside the National Park (TRC, 2015c) was 102 units. The historical, spring and summer scores were not significantly different to the TRC, 2015c value. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical, spring and summer scores were all significantly higher than the REC value by 12 to 14 units (Stark, 1998).

3.2.3.2.4 Temporal trends in 1996 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 15). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1996-2017) from the site in the Huatoki Stream at Huatoki Domain.



N = 41
Kendall tau = +0.431
p level < 0.001
FDR p < 0.001

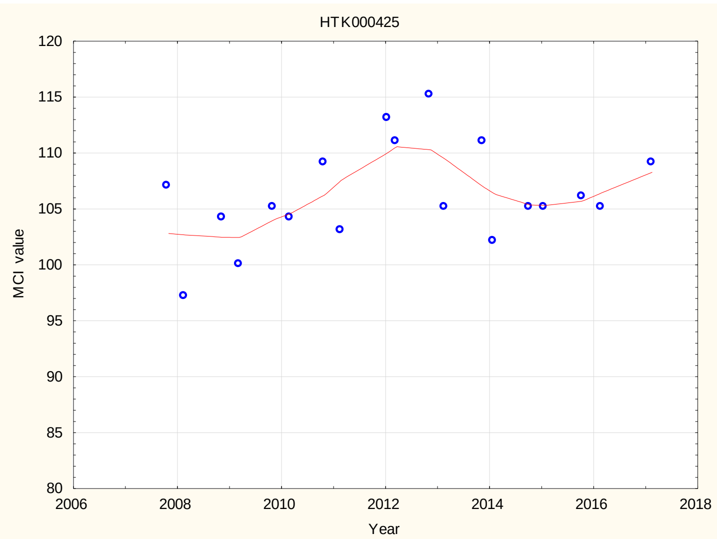
Figure 15 LOWESS trend plot of MCI data in the Huatoki Stream for the Huatoki Domain site

A similar temporal trend of a marked improvement in MCI scores, but not as strong as that found at the upstream site (at Hadley Drive), was identified at this site in the Domain although scores peaked with small decreases after 2006 and 2012. The overall trend has been very significant after FDR application (p< 0.01) and the trendline range of scores (10 units) although only of marginal ecological importance. The trend has probably been related to the upstream catchment activities noted above as no nearby habitat changes have been recorded within the Domain.

The trendline MCI scores which indicated 'fair' generic stream health (Table 2) much earlier in the monitoring period, improved to 'good' stream health where they have remained since 2002.

3.2.3.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 16). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2006-2016) from the site in the Huatoki Stream at Huatoki Domain.



N = 19
Kendall tau = +0.231
p level = 0.167
FDR = 0.467

Figure 16 LOWESS trend plot of ten years of MCI data in the Huatoki Stream for the Huatoki Domain site

A minor non-significant positive trend occurred over the ten year period in contrast with the significant positive trend of the full dataset. Though the trendline show some minor variation within the ten year period with a rise in MCI scores from 2009 to 2013 little overall change in the trendline occurred. The trendline was indicative of 'good' generic stream health (Table 2).

3.2.3.3 Site near coast (HTK000745)

3.2.3.3.1 Taxa richness and MCI

Forty surveys have been undertaken at this lower reach site in the Huatoki Stream between December 1996 and February 2016. These results are summarised in Table 16, together with the results from the current period, and illustrated in Figure 17.

Table 16 Results of previous surveys performed in Huatoki Stream at the site near the coast, together with the summer 2017 result

Site code	SEM data (1996 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
HTK000745	40	14-27	22	69-101	86	20	97

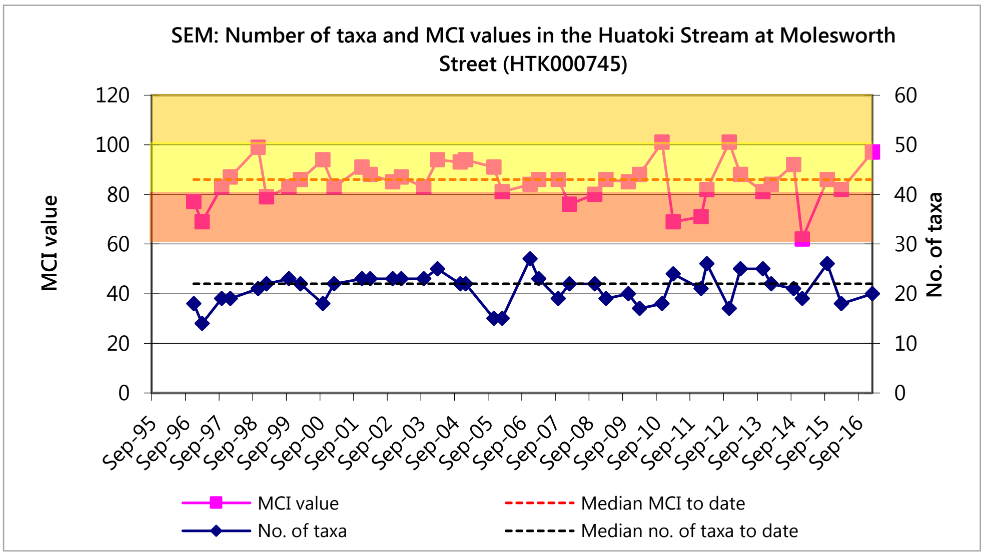


Figure 17 Numbers of taxa and MCI values in the Huatoki Stream at Molesworth Street (near coast)

A moderate range of richnesses (14 to 27 taxa) has been found, with a median richness of 22 taxa (more representative of typical richnesses in the lower reaches of ringplain streams rising outside the National Park boundary). During the 2016-2017 period summer (20 taxa) richness was only two taxa different from the historical median richness.

MCI values have had a relatively wide range (32 units) at this site. However, the median value (86 units) has been typical of lower reach sites elsewhere on the ringplain. The summer 2017 (97 units) score was significantly (Stark, 1998) higher than the historical median by 11 units and was the higher score recorded during the summer survey to date. The MCI scores categorised this site as having 'fair' health generically (Table 2). The historical median score (86 units) also placed this site in the 'fair' category for generic health.

3.2.3.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 17.

Table 17 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Huatoki Stream at the site near the coast, between 1996 and 2016 [40 surveys], and summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
NEMERTEA	Nemertea	3	1			1	3	
ANNELIDA (WORMS)	Oligochaeta	1	7	18	15	40	100	XA
MOLLUSCA	*Ferrissia*	3	1			1	3	
	Latia	5	3			3	8	
	Potamopyrgus	4	5	11	24	40	100	VA
	Sphaeriidae	3	1			1	3	
CRUSTACEA	Ostracoda	1	2			2	5	
	Paratya	3	2	1		3	8	
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	3	1		4	10	
	Zephlebia group	7	6			6	15	
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	4			4	10	
COLEOPTERA (BEETLES)	Elmidae	6	8	11	5	24	60	XA
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	3			3	8	
	Oxyethira	2	1			1	3	
	Pycnocentrodes	5	6	4		10	25	
	Triplectides	5	2			2	5	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	1			1	3	
	Orthocladiinae	2	11	3		14	35	
	Polypedilum	3		1		1	3	
	Empididae	3	2			2	5	
	Austrosimulium	3	1			1	3	
	Tanyderidae	4	5			5	13	

Prior to the current 2016-2017 period, 22 taxa had characterised the community at this site on occasions. These have comprised eight 'moderately sensitive' and 14 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream.

Taxa that have been characteristic taxa for over 50% of the time included one 'moderately sensitive' taxon [elmid beetles] and two 'tolerant' taxa [oligochaete worms and snail (*Potamopyrgus*); both "tolerant" taxa characteristic on every occasion]. Only three of the historically characteristic taxa were dominant in the summer 2017 community. These were mostly 'tolerant' species which was reflected in the low $SQMCI_s$ score of 3.6 units. (Table 132).

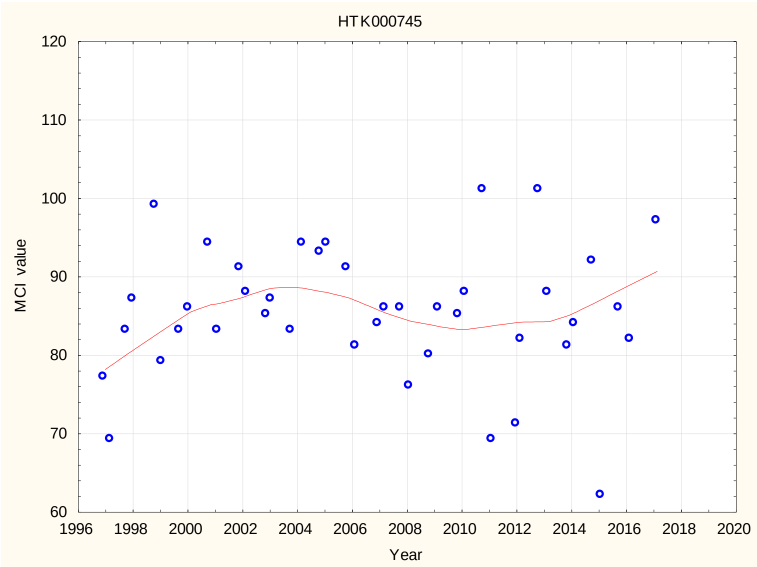
3.2.3.3.3 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site near the coast is in the lower reaches at an altitude of 5 m asl.

The median value for a ringplain stream arising outside the National Park (TRC, 2016b) was 84 units. The historical median was not significantly different to this value but the summer score was higher (Stark, 1998) by 13 units. The REC predicted MCI value (Leathwick, et al. 2009) was 93 units. The historical and summer scores were not significantly different to the REC value (Stark, 1998).

3.2.3.3.4 Temporal trends in 1996 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 18). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 21 years of SEM results (1996-2017) from the site in the Huatoki Stream near the coast.



N = 41
Kendall tau = 0.010
p level = 0.927
FDR p = 0.940

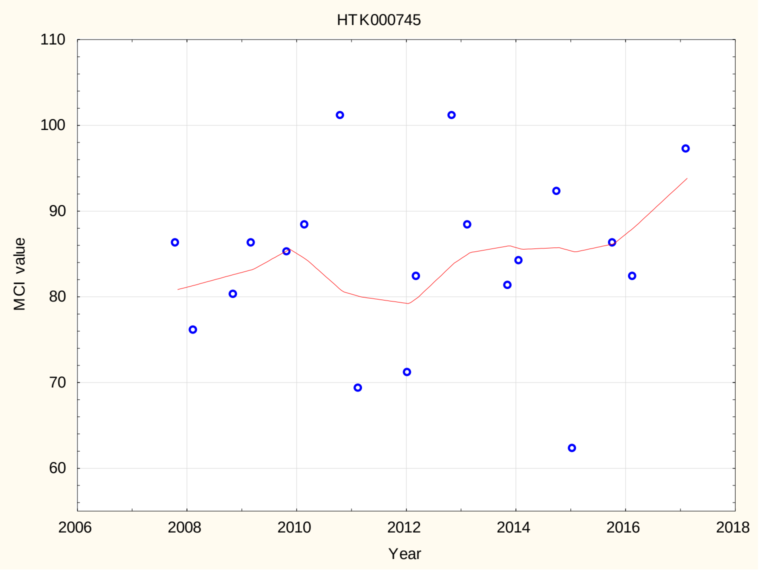
Figure 18 LOWESS trend plot of MCI data for the site in the Huatoki Stream near the coast

A trend of steady improvement in smoothed MCI scores had occurred at this urbanised site until 2004 after which scores trended downward until plateauing more recently (with much more variability amongst individual scores) following the pulsed flows and subtle habitat changes caused by the beautification project which involved construction of a weir and a fishpass. Overall, there was a slight positive non-significant trend. The trendline range of scores (13 units) has some ecological importance probably related in part to those activities noted for the two sites further upstream in the Huatoki catchment (see above) and the stream enhancement project specific to the reach immediately upstream of this site.

Smoothed MCI scores indicative of 'fair' generic stream health (Table 2) have been recorded for all but the first years of the monitoring programme (Figure 18).

3.2.3.3.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 19). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Huatoki Stream near the coast.



N = 19
Kendall tau = 0.101
p level = 0.545
FDR p = 0.758

Figure 19 LOWESS trend plot of ten years of MCI data for the site in the Huatoki Stream near the coast

There was a slight positive trend over the ten year period but the trend was highly non-significant. The trendline was indicative of 'fair' generic stream health (Table 2).

3.2.3.4 Discussion

No spring surveys could be performed at this stream due to persistently high flows. Historically, there have been median summer MCI decreases of six units at the Hadley Drive site, three units at the Huatoki Domain site, and one unit change near the coast (Appendix II).

The two upper sites at Hadley Drive and Huatoki Domain had 'good' macroinvertebrate health while the lower site on Molesworth Street had 'fair' macroinvertebrate health. There was little difference in the overall health between the two upstream communities while there was a significant decrease at the lower site which can be attributed to .increased urbanisation, habitat modification and deterioration in water quality.

MCI scores indicated a significant improvement in the health of the macroinvertebrate communities at the Hadley Drive and Molesworth Street sites where there were significantly higher summer MCI scores recorded compared with historic medians. Persistently high flows during spring have likely kept periphyton levels down, especially in the less shaded upper site, which was likely a contributing factor to the healthier than normal communities at the two sites.

3.2.4 Kapoaiaia Stream

The Kapoaiaia Stream is a small ringplain stream running east to west with a source situated inside Egmont National Park. This stream was selected for the purpose of monitoring a western Taranaki ringplain catchment with minimal existing riparian vegetation cover. Three established sites in the Kapoaiaia Stream, located at Wiremu Road (in open farmland nearly 6 km below the National Park boundary), Wataroa Road bridge (nearly 8 km further downstream), and about 0.8 km from the coast (in open farmland about 8 km further downstream, i.e. 25 km below the National Park boundary), were included in the SEM programme commencing in the 2000-2001 year. Biological sampling had been undertaken previously in this catchment as a component of the Taranaki ringplain survey (TCC, 1984) and on various occasions in relation to the Pungarehu Dairy Factory (closed since 1995).

The results of the spring 2016 and summer 2017 surveys are presented in Table 133 and Table 134, Appendix I.

3.2.4.1 Wiremu Road site (KPA000250)

3.2.4.1.1 Taxa richness and MCI

Thirty-four surveys have been undertaken in the Kapoaiaia Stream between March 1998 and February 2016 at this open, upper mid-reach site in farmland, 5.7 km downstream of the National Park. These results are summarised in Table 18 together with the results from the current period, and illustrated in Figure 20.

Table 18 Results of previous surveys performed in the Kapoaiaia Stream at Wiremu Road together with the spring 2016 and summer 2017 results

Site code	SEM data (1998 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000250	34	19-31	25	83-131	116	26	125	19	115

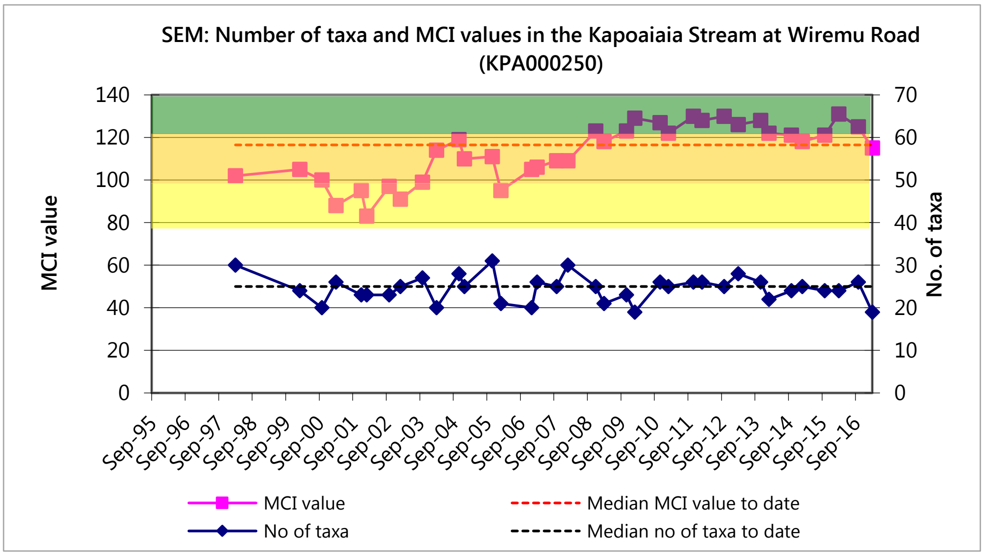


Figure 20 Numbers of taxa MCI values in the Kapoaiaia Stream at Wiremu Road

A moderate range of richnesses (19 to 31 taxa) has been found with a median richness of 25 taxa (more typical of richnesses in the mid-reaches of ringplain streams and rivers). During the 2016-2017 period, spring (26 taxa) and summer (19 taxa) richnesses were seven taxa apart and within six taxa of the historical median.

MCI values have had a wide range (48 units) at this site, wider than typical of a site in the upper mid-reaches of a ringplain stream although this site is in a reach of very open farmland, nearly 6km downstream from the National Park boundary. The spring 2016 (125 units) and summer 2017 (115 units) scores were not significantly different (Stark, 1998) from the historic median. These scores categorised this site as having 'very good' generic health (Table 2) in spring and 'good health' in summer. The historical median score (116 units) placed this site in the 'good' generic health.

3.2.4.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 19.

Table 19 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Kapoaiaia Stream at Wiremu Road between 1995 and February 2016 [34 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	5	3	4	12	35		
MOLLUSCA	*Potamopyrgus*	4	3			3	9		
CRUSTACEA	*Paracalliope*	5	1			1	3		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	6	1		7	21		
	Coloburiscus	7	7	16	1	24	71	VA	
	Deleatidium	8	4	6	16	26	76	XA	XA
	Nesameletus	9	9	3		12	35	A	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	5	1		6	18		
	Zelandoperla	8	9	4		13	38	A	
COLEOPTERA (BEETLES)	Elmidae	6	16	12	3	31	91		A
	Hydraenidae	8	1			1	3		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	6			6	18		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	16	6	5	27	79	A	
	Costachorema	7	16	1		17	50		
	Hydrobiosis	5	9	1		10	29		
	Beraeoptera	8	2	3	3	8	24		
	Helicopsyche	10	2			2	6	A	
	Olinga	9	1			1	3		
	Oxyethira	2	4			4	12		
	Pycnocentrodes	5	6	3	2	11	32	A	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	20	3		23	68	A	VA
	Eriopterini	5	1			1	3		
	Maoridiamesa	3	9	7	6	22	65	A	VA
	Orthocladiinae	2	10	8	7	25	74		
	Tanytarsini	3	2			2	6		
	Muscidae	3	3			3	9		
	Austrosimulium	3	4	1		5	15		

Prior to the current 2016-2017 period, a high number of taxa (25) had characterised the community at this site on occasions. These have comprised five 'highly sensitive', eleven 'moderately sensitive', and nine 'tolerant' taxa i.e. a high proportion of 'sensitive' taxa as would be expected in the upper mid-reaches of a ringplain stream but also a relatively higher number of 'tolerant' taxa for a site within 6km of the National Park boundary. Taxa that have been characteristic taxa for over 50% of the time have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Costachorema*), and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and midges (orthoclads and *Maoridiamesa*)]. The spring 2016 community consisted of nine characteristic taxa that were mostly 'sensitive' species which was reflected in the high $SQMCI_s$ score of 7.5 units indicating 'excellent' macroinvertebrate health (Table 19). The summer 2017 community consisted of five characteristic taxa that were mostly 'sensitive' species which was reflected in the high $SQMCI_s$ score of 6.7 units indicating 'very good' macroinvertebrate health.

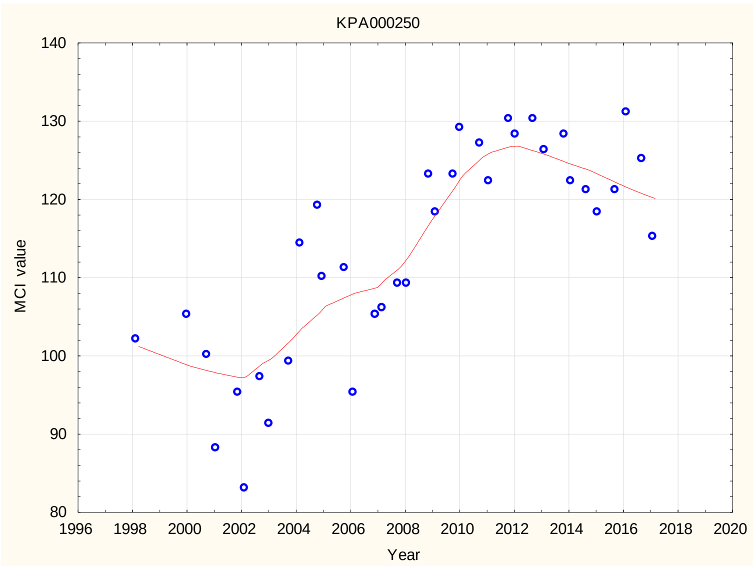
3.2.4.1.3 Predicted stream 'health'

The Kapoaiaia Stream site at Wiremu Road is 5.7 km downstream of the National Park boundary at an altitude of 240 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 112 for this site. The historical site median (116 units) was not significantly different from the distance predictive value. The spring 2016 survey score (125 units) was significantly higher but the summer 2017 survey (115 units) was not significantly different (Stark, 1998).

The median value for a ringplain stream arising inside the National Park (TRC, 2016b) was 101 units. The historical, spring and summer scores score were all significantly higher by 15, 24 and 14 units respectively than this value. The REC predicted MCI value (Leathwick, et al. 2009) was 111 units. The historical and summer scores were not significantly different to the REC value but the spring score was significantly higher by 14 units (Stark, 1998).

3.2.4.1.4 Temporal trends 1998 to 2017

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 21). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 19 years of SEM results (1998-2017) from the site in the Kapoaiaia Stream at Wiremu Road.



N = 36
Kendall tau = +0.545
p level < 0.001
FDR, p < 0.001

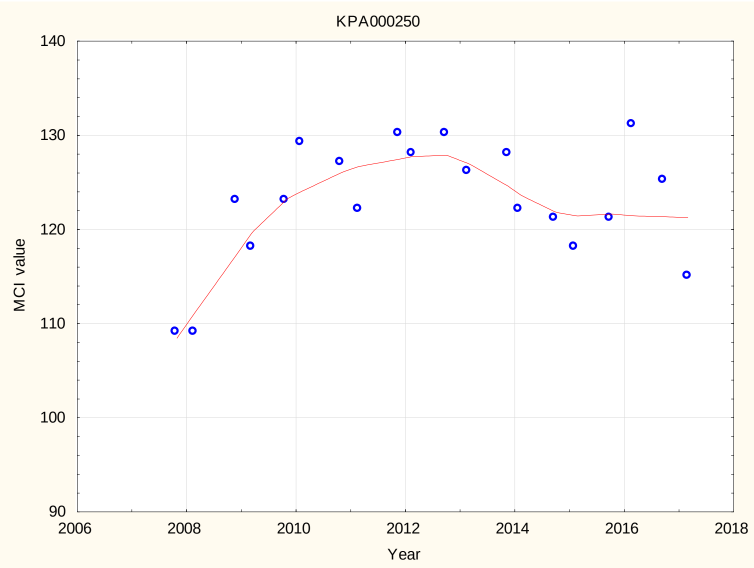
Figure 21 LOWESS trend plot of MCI data in the Kapoaiaia Stream at the Wiremu Road site

A very significant trend of improvement in MCI scores has been found over the 19 year duration of this monitoring period (FDR p<0.01). There has been an ecologically important variability in the extremely wide (30 units) range of trendline scores at this site also. This appears to have been related to farming practices, particularly variations in fertiliser usage, through the open reach between the National Park boundary and this upper site, which may have been exacerbated by the lack of riparian vegetation along this reach.

The trendline scores were indicative of generic stream health (Table 2) varying between 'fair' and 'very good' have been slightly lower than might be expected at times (particularly prior to 2004) at this site approximately 6 km below the National Park. A strong improvement has been obvious between 2007 and 2012 when it plateaued with some deterioration in 'health' over the 2013 to 2016 period.

3.2.4.1.5 Temporal trends 2007 to 2017

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 22). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Kapoaiaia Stream at Wiremu Road.



N = 20
Kendall tau = +0.080
p level = 0.620
FDR, p = 0.827

Figure 22 LOWESS trend plot of ten years of MCI data in the Kapoaiaia Stream at the Wiremu Road site

A positive trend in MCI scores has been found over the ten-year period but the trend was non-significant in constract to the significant positive result for the full dataset. The trendline range was generally indicative of 'very good' health (Table 2).

3.2.4.2 Wataroa Road site (KPA000700)

3.2.4.2.1 Taxa richness and MCI

Thirty-four surveys have been undertaken in the Kapoaiaia Stream at this mid-reach site at Wataroa Road between December 1996 and February 2016. These results are summarised in Table 20, together with the results from the current period, and illustrated in Figure 23.

Table 20 Results of previous surveys performed in the Kapoaiaia Stream at Wataroa Road, together with spring 2016 and summer 2017 results

Site code	SEM data (1996 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000700	34	12-30	21	78-118	95	23	107	20	100

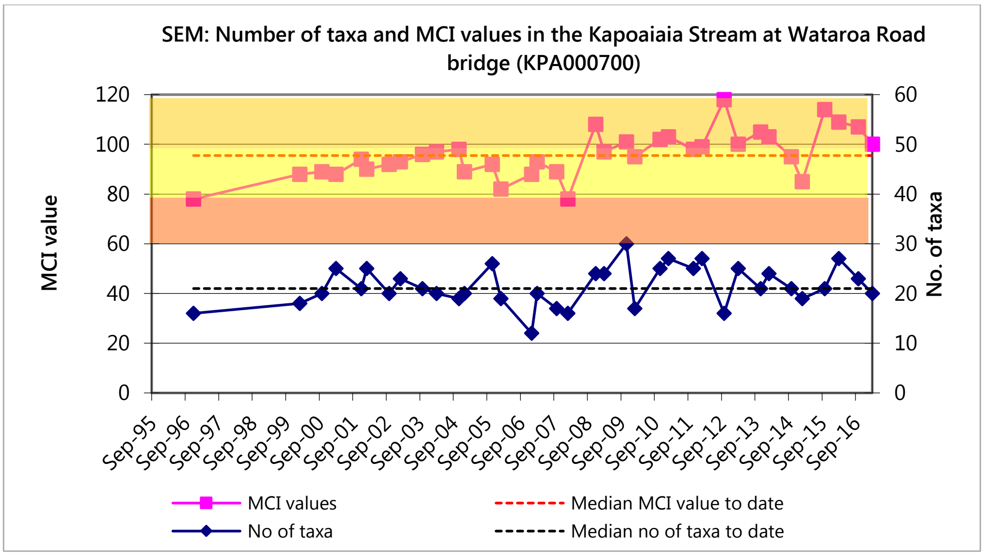


Figure 23 Numbers of taxa and MCI values in the Kapoaiaia Stream at Wataroa Road

A wide range of richnesses (12 to 30 taxa) has been found, with a median richness of 21 taxa, relatively typical of richnesses in the mid-reaches of ringplain streams and rivers. During the 2016-2017 period, spring (23 taxa) and summer (20 taxa) richnesses were similar to the historic median. MCI values have had a relatively wide range (40 units) at this site, more so than typical of many sites in the mid-reaches of ringplain rivers. The historical median value (95 units) is lower than values typical of mid-reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (107 units) was significantly higher than the historical median by 11 units but the summer 2017 (100 units) scores was not significantly different. These scores categorised this site as having 'good' (spring and summer) health generically (Table 2). The historical median score (95 units) placed this site in the 'fair' category for generic health.

3.2.4.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed inTable 21.

Table 21 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Kapoaiaia Stream at Wataroa Road between 1995 and February 2016 [34 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
PLATYHELMINTHES (FLATWORMS)	Cura	3	1			1	3		
NEMATODA	Nematoda	3	1			1	3		
ANNELIDA (WORMS)	Oligochaeta	1	7	7	4	18	53		
	Lumbricidae	5	1			1	3		
MOLLUSCA	Potamopyrgus	4	4	3		7	21		
EPHEMEROPTERA (MAYFLIES)	Austroclima	7	3			3	9		
	Coloburiscus	7	4	4		8	24		
	Deleatidium	8	7	6	6	19	56	XA	XA

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
	Nesameletus	9	1			1	3		
PLECOPTERA (STONEFLIES)	*Acroperla*	5	4			4	12		
	Zelandobius	5	1			1	3	A	
COLEOPTERA (BEETLES)	Elmidae	6	11	14	4	29	85		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	12			12	35		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	10	12	2	24	71		A
	Costachorema	7	14	2		16	47		
	Hydrobiosis	5	15	4		19	56		
	Oxyethira	2	2			2	6		
	Pycnocentrodes	5	10	2		12	35	A	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	16	2		18	53		VA
	Maoridiamesa	3	10	12	1	23	68		A
	Orthocladiinae	2	9	16	5	30	88		
	Tanytarsini	3	4	3		7	21		
	Empididae	3	4	1		5	15		
	Muscidae	3	4			4	12		
	Austrosimulium	3	10	1		11	32		

Prior to the current 2016-2017 period, 24 taxa had characterised the community at this site on occasions. These have comprised two 'highly sensitive', ten 'moderately sensitive', and twelve 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increase in the number of 'tolerant' taxa to a higher proportion than might be expected in the mid reaches of a ringplain stream. Taxa that have been characteristic taxa for over 50% of surveys included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [elmid beetles, free-living caddisflies (*Costachorema* and *Hydrobiosis*), and cranefly (*Aphrophila*)]; and four 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)] (Table 105).

The spring 2017 community consisted of three characteristic taxa that were all sensitive taxa which reflected the high $SQMCI_s$ score of 7.5 units indicating 'excellent' macroinvertebrate health. The summer 2017 community consisted of four historically characteristic taxa. Again, there was a high $SQMCI_s$ score of 7.0 units indicating 'excellent' macroinvertebrate health.

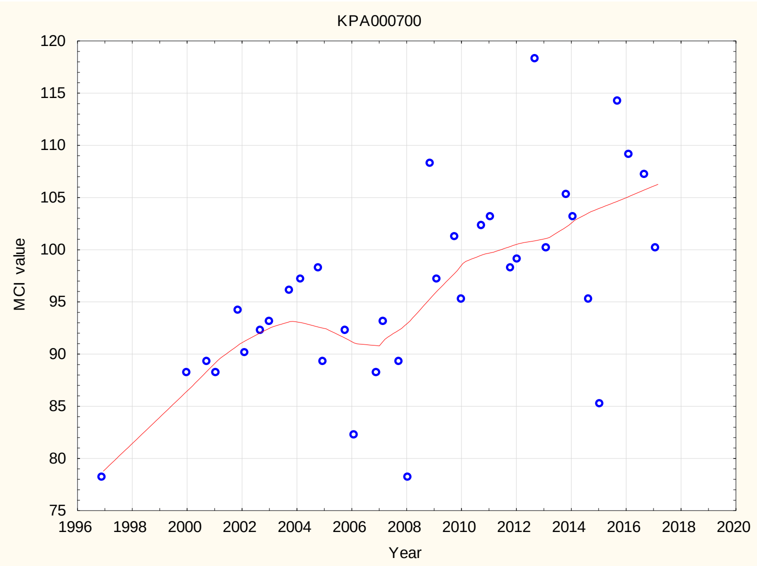
3.2.4.2.3 Predicted stream 'health'

The Kapoaiaia Stream site at Wataroa Road, is 13.5 km downstream of the National Park boundary at an altitude of 140 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 103 for this site. The historical site median (95) was not significantly different to the distance predictive value. The spring 2016 (107 units) and summer, 2017 (100 units scores) were not significantly different (Stark, 1998) to the predictive value.

The median value for a ringplain stream arising inside the National Park (TRC, 2016b) was 103 units. The historical, spring and summer scores score were all not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 105 units. The historical, spring and summer scores were all not significantly different to the REC predictive value.

3.2.4.2.4 Temporal trends in 1996 to 2017

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 24). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 21 years of SEM results (1996-2017) from the site in the Kapoaiaia Stream at Wataroa Road.



N = 36
Kendall tau = +0.491
p level < 0.001
FDR p < 0.001

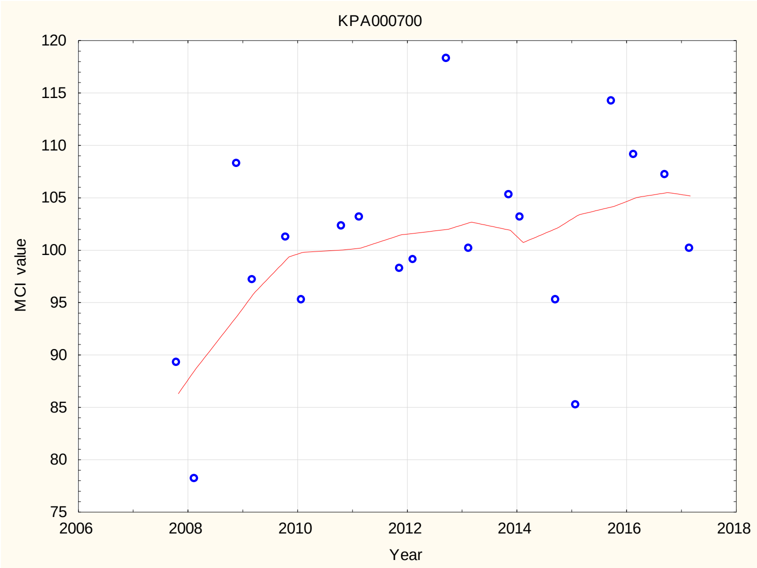
Figure 24 LOWESS trend plot of MCI data in the Kapoaiaia Stream at the Wataroa Road site

There was a significant positive trend over the 21-year period (FDR p<0.01). Although the initial six years of the monitoring programme indicated a significant temporal improvement in MCI scores, these tended to decline between 2004 and 2007. Further, more recent improvement has resulted in a positive trend. The range of trendline scores (28 units) have been ecologically important although it has been influenced by an initial very low score. From 2000 to date this range (12 units) has been of ecological importance. This trend of improvement had been influenced probably by the same drivers of the marked improvement at the Wiremu Road site upstream.

MCI scores across the trendline have consistently indicated ‘fair’ generic stream health (Table 2) at this mid-catchment site, improving to ‘good’ from 2012 onwards.

3.2.4.2.5 Temporal trends in 2007 to 2017

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 25). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Kapoaiaia Stream at Wataroa Road.



N = 20
Kendall tau = +0.270
p level = 0.095
FDR p = 0.381

Figure 25 LOWESS trend plot of ten years of MCI data in the Kapoaiaia Stream at the Wataroa Road site

A positive non-significant trend in MCI scores after FDR adjustment has been found over the ten year period in contrast with the highly significant positive result found in the full dataset. The trendline was indicative of 'fair' to 'good' health (Table 2).

3.2.4.3 Upstream of coast site (KPA000950)

3.2.4.3.1 Taxa richness and MCI

Thirty-four surveys have been undertaken at this lower reach site near the coast in the Kapoaiaia Stream between December 1996 and February 2016. These results are summarised in Table 22, together with the results from the current period, and illustrated in Figure 24.

Table 22 Results of previous surveys performed in the Kapoaiaia Stream at the site upstream of the coast together with spring 2016 and summer 2017 results

Site code	SEM data (1996 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000950	34	15-24	19	76-101	86	18	88	16	93

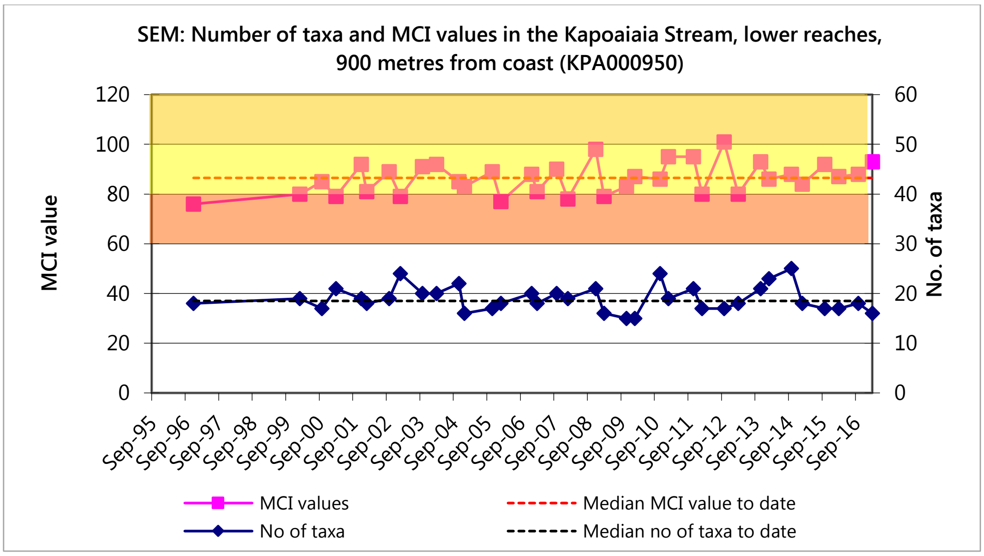


Figure 26 Numbers of taxa and MCI values in the Kapoaiaia Stream at the Cape Egmont (upstream of coast) site

A moderate range of richnesses (15 to 24 taxa) has been found with a median richness of 19 taxa relatively typical of richnesses in the lower reaches of ringplain streams and rivers. During the 2016-2017 period, spring (18 taxa) and summer (16 taxa) richnesses were similar to the historic median.

MCI scores have had a moderate range (25 units) at this site, slightly narrower than typical of sites in the lower reaches of ringplain streams. However, the median value (86 units) has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (88 units) and summer 2017 (93 units) scores were not significantly different from the historical median. The MCI scores categorised this site as having 'fair' (spring and summer) health generically (Table 2). The historical median score (86 units) also placed this site in the 'fair' category for generic health.

3.2.4.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 23.

Table 23 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Kapoaiaia Stream at the site upstream of the coast between 1995 and February 2016 [34 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	1			1	3		
NEMERTEA	Nemertea	3	1			1	3		
ANNELIDA (WORMS)	Oligochaeta	1	12	7	11	30	88	A	XA
	Lumbricidae	5	1			1	3		
MOLLUSCA	*Potamopyrgus*	4	12	11	1	24	71	A	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	2			2	6		A
	Deleatidium	8	4	1		5	15	A	A
PLECOPTERA (STONEFLIES)	*Zelandperla*	5						A	

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
COLEOPTERA (BEETLES)	Elmidae	6	5	14		19	56		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	3			3	9		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	10	14	4	28	82	A	VA
	Costachorema	7	2			2	6		
	Hydrobiosis	5	19	3		22	65		
	Oxyethira	2	5			5	15		
	Pycnocentrodes	5	7	11	1	19	56	A	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	9	1		10	29		VA
	Chironomus	1	1			1	3		
	Maoridiamesa	3	5	12	3	20	59	A	
	Orthocladiinae	2	10	14	9	33	97	A	VA
	Tanytarsini	3	8			8	24		
	Empididae	3	1			1	3		
	Muscidae	3	4			4	12		
	Austrosimulium	3	5	2		7	21		A

Prior to the current 2016-2017 period 22 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', eight 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as might be expected in the lower reaches of a ringplain stream. Taxa that have been characteristic taxa over 50% of the time included three 'moderately sensitive' taxa [elmid beetles, free-living caddisfly (*Hydrobiosis*) and stony-cased caddisfly (*Pycnocentrodes*)]; and five 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)]. The spring 2016 community consisted of eight characteristic taxa comprising a mixture of 'sensitive' and 'tolerant' taxa which was reflected in the SQMCIs score of 4.2 units indicating 'fair' health. The summer 2017 community consisted of seven characteristic taxa with high numbers of 'tolerant' taxa (Table 23) which contributed to very low score SQMCIs score of 2.4 units which indicated 'very poor' macroinvertebrate health (Table 133 and Table 134).

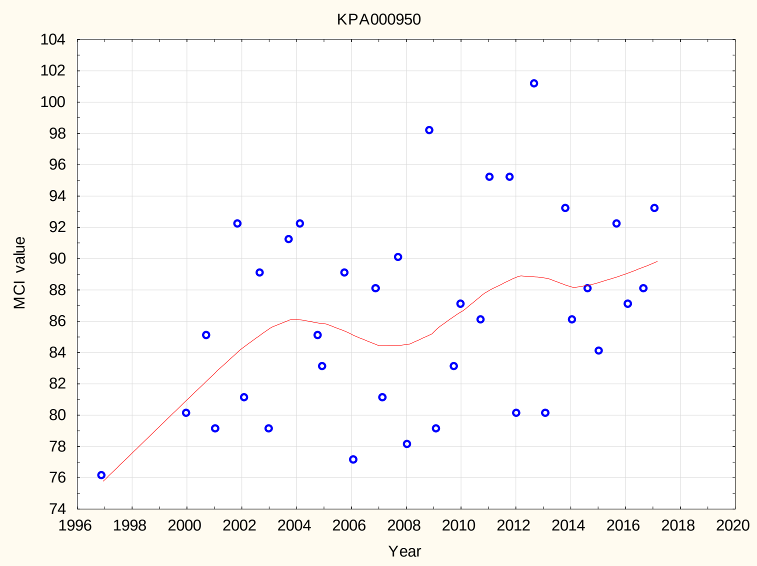
3.2.4.3.3 Predicted stream 'health'

The Kapoaiaia Stream site near the coast is 25.2 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 96 for this site. The historical site median (86 units) is ten units lower than the distance predictive value. The spring 2016 survey (88 units) and summer 2017 (93 units) scores were not significantly different to the predictive value (Stark, 1998).

The median value for a ringplain stream arising inside the National Park (TRC, 2016b) at similar altitude was 90 units. The historical, spring and summer scores were not significantly different. The REC predicted MCI value (Leathwick, et al. 2009) was 99 units. The historical and spring scores were all significantly lower than the REC value (Stark, 1998) by 13 and 11 units respectively while the summer score was not significantly different.

3.2.4.3.4 Temporal trends in 1996 to 2017

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 27). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 21 years of SEM results (1996-2017) from the site in the Kapoaiaia Stream at near the coast.



N = 36
Kendall tau = +0.245
p level = 0.035
FDR p = 0.063

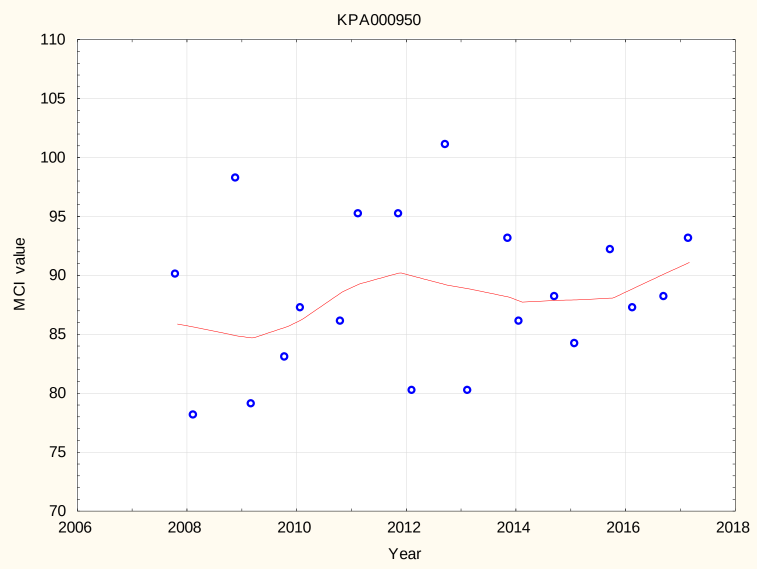
Figure 27 LOWESS trend plot of MCI data at the site upstream of the coast

No statistically significant trend has been found for the overall monitoring period despite a steady improvement in MCI scores over the initial seven year period followed by a smaller increase between 2008 and 2012 (FDR p>0.05). There has been a similar, although more pronounced, trend at the mid-catchment site at Wataroa Road. However, there has been an ecologically important range (of 13 units) across the trendline, influenced by the low initial score, but not as wide as the range at the nearest upstream site. Subsequent to the December 1996 survey, no usage of the Pungarehu Dairy Factory (between the two sites) has occurred and since 2000 there has been a narrower, ecologically insignificant, range of MCI scores (eight units). In more recent years, there has been an increase in water abstraction in the lower reaches for irrigation purposes.

The trendline range of MCI scores have consistently been indicative of 'fair' generic stream health (Table 2) although individual scores have occasionally indicated 'poor' health, invariably under summer (warmer and lower) flow conditions.

3.2.4.3.5 Temporal trends in 2007 to 2017

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 28). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Kapoaiaia Stream at near the coast.



N = 20
Kendall tau = +0.150
p level = 0.356
FDR p = 0.604

Figure 28 LOWESS trend plot of ten years of MCI data in the Kapoaiaia Stream at the site upstream of the coast

A positive non-significant trend in MCI scores has been found over the ten year period congruent with the non-significant positive result found in the full dataset. The ten year dataset trendline showed a slight increase from 2009 to 2012 before declining to 2014. The trendline was indicative of 'fair' health (Table 2).

3.2.4.4 Discussion

The upper and middle sites had typical, moderately high taxa richnesses. MCI and $SQMCI_s$ scores indicated 'good' to 'excellent' macroinvertebrate health with significant positive trends indicating that the macroinvertebrate community was improving. The lower site had moderate taxa richness similar to historic medians. MCI scores indicated 'fair' macroinvertebrate health for spring and summer and the spring SQMCIs score also indicated 'fair' health in spring. However, a significant decrease in SQMCIs score recorded during the summer survey, a very low 2.4 units, indicated 'very poor' macroinvertebrate health. The lower site also did not have a significantly positive trend for MCI scores, unlike the upper two sites, indicating that health was not significantly improving.

The MCI scores fell in a downstream direction between the upper mid-reach (Wiremu Road) site and the lower reaches site near the coast by a significant 37 units in spring and to a lesser extent in summer by 22 units, over a river distance of 19.5 km. This contrasts with the historic median differences between the upper and lower sites where there was a decrease of 31 units in both spring and summer and $SQMCI_s$ scores where there was a significantly larger decrease in summer of 4.3 units compared with the decrease in spring of 3.3 units. The deterioration in macroinvertebrate health was likely due to nutrient enrichment from cumulative inputs from point and diffuse sources.

3.2.5 Katikara Stream

The Katikara Stream is a ringplain stream running from east to west arising within Egmont National Park. Two sites in the Katikara Stream, one located near the headwaters (just inside the National Park) and the other near the coast, were first included in the SEM programme in the 2000-2001 year, for the purpose of long term monitoring of the progressive impacts of riparian vegetation planting initiatives within this north-western Taranaki catchment. In the 2008-2009 period severe headwater erosion events impacted upon the macroinvertebrate communities of the upper reaches of this stream (TRC, 2009). Due to persistently high flows no spring 2016 survey was able to be completed. The results for summer 2017 survey are presented in Appendix I.

3.2.5.1 Carrington Road site (KTK000150)

3.2.5.1.1 Taxa richness and MCI

Thirty-four surveys have been undertaken at this upper reach site in the Katikara Stream inside the National park boundary at Carrington Road between September 1999 and March 2016. These results are summarised in Table 24 together with the results from the current period, and illustrated in Figure 29.

Table 24 Results of previous surveys performed in the Katikara Stream at Carrington Road, together with summer 2017 results

Site code	SEM data (1999 to February 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
KTK000150	34	11-38	29	112-148	136	17	135

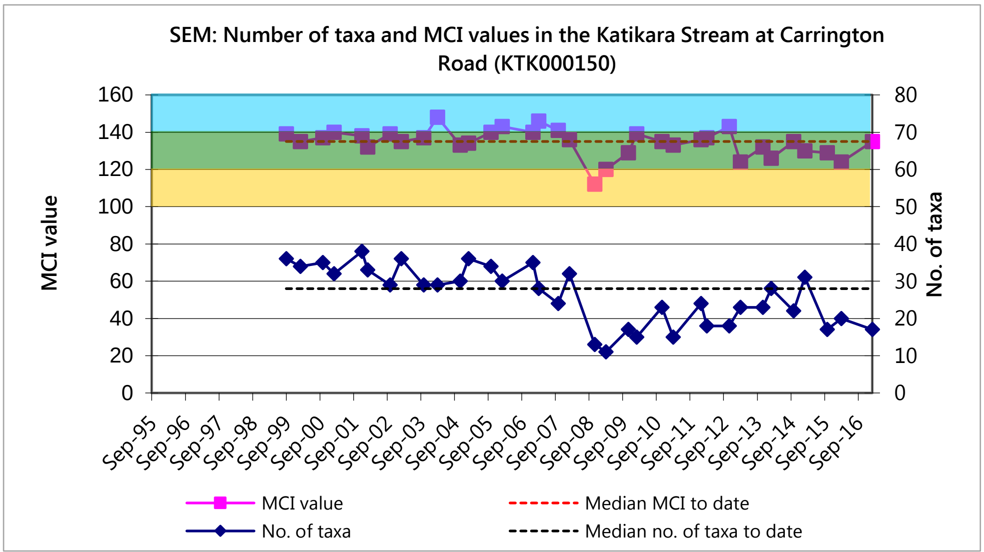


Figure 29 Numbers of taxa and MCI values in the Katikara Stream at Carrington Road

A very wide range of richnesses (11 to 38 taxa) has been found; wider than might be expected, due to the impacts of significant headwater erosion over the 2008-2009 period and subsequent recovery from these effects. The median richness of 29 taxa has been far more representative of typical richnesses in ringplain streams and rivers near the National Park boundary (TRC, 2016b), although median richness since the 2008-2009 erosion event has been 20 taxa (Figure 29). During the 2016-2017 period summer (17 taxa) richness was well below the long-term median richness indicative of a continuing post-headwater erosion recovery phase and resulting in degradation of the physical habitat (Figure 29).

MCI values at this site have had a wider range (36 units) than typical of a National Park boundary site, due in part to atypically lower values for a short period and on other isolated occasions since the 2008-2009 headwater erosion event. The median value (136 units) has been typical of upper reach sites (near or within the National Park) elsewhere on the ringplain (TRC, 2016b). The summer 2017 (135 units) score was not significantly different to the historical median (136 units). The score categorised this site as having 'very good' health generically (Table 2) although taxa numbers in general continued to be lower than typical pre-erosion richnesses. The historical median score (136 units) also placed this site in the 'very good' category for the generic health.

3.2.5.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 25.

Table 25 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Katikara Stream at Carrington Road between 1999 and March 2016 [34 surveys], and by the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	1			1	3	
	Austroclima	7	12	3		15	44	
	Coloburiscus	7	16	8	1	25	74	
	Deleatidium	8	11	16	4	31	91	
	Nesameletus	9	20	1		21	62	
PLECOPTERA (STONEFLIES)	*Acroperla*	5	2			2	6	
	Austroperla	9	7			7	21	
	Zelandobius	5	14	7		21	62	A
	Zelandoperla	8	11	7		18	53	
COLEOPTERA (BEETLES)	Elmidae	6	6	1		7	21	
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	2			2	6	
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	1			1	3	A
	Hydrobiosis	5	1			1	3	
	Hydrobiosella	9	7			7	21	
	Hydropsyche (Orthopsyche)	9	8			8	24	VA
	Beraeoptera	8	1			1	3	
	Oxyethira	2	1			1	3	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	5			5	15	
	Orthocladiinae	2	17			17	50	
	Polypedilum	3	1			1	3	A

Prior to the current 2016-2017 period, 20 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', nine 'moderately sensitive', and three 'tolerant' taxa i.e a majority of 'sensitive' taxa as would be expected near the National Park boundary of a ringplain stream. Predominant taxa have included three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*) and stonefly (*Zelandoperla*)]; three 'moderately sensitive' taxa [mayflies (*Coloburiscus* and *Austroclima*), and stonefly (*Zelandobius*)]; and one 'tolerant' taxon [orthoclad midges]. The summer 2017 community consisted of four characteristic taxa that were mostly sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.2 units indicating 'excellent' macroinvertebrate health (Table 25 and Table 165).

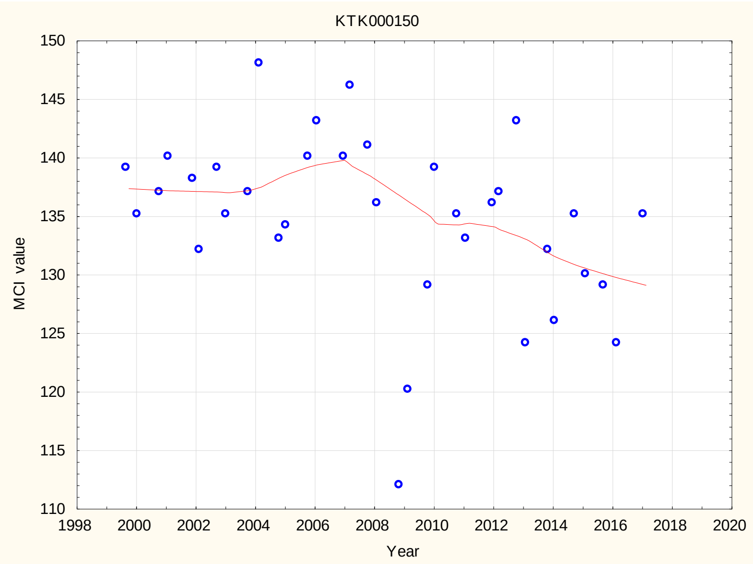
3.2.5.1.3 Predicted stream 'health'

The Katikara Stream at Carrington Road is within the National Park boundary at an altitude of 420 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI value of 132 for this site. The historical site median (136 units) is four units higher than the distance predictive value. The summer (135 units) scores were not significantly different to the predictive value.

The median value for a ringplain stream arising inside the National Park (TRC, 2016b) was 134 units. The historical and summer scores were not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 131 units. Again, the historical and summer scores were not significantly different to the REC value (Stark, 1998).

3.2.5.1.4 Temporal trends in 1999 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 30). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 18 years of SEM results (1999-2017) from the site in the Katikara Stream at Carrington Road.



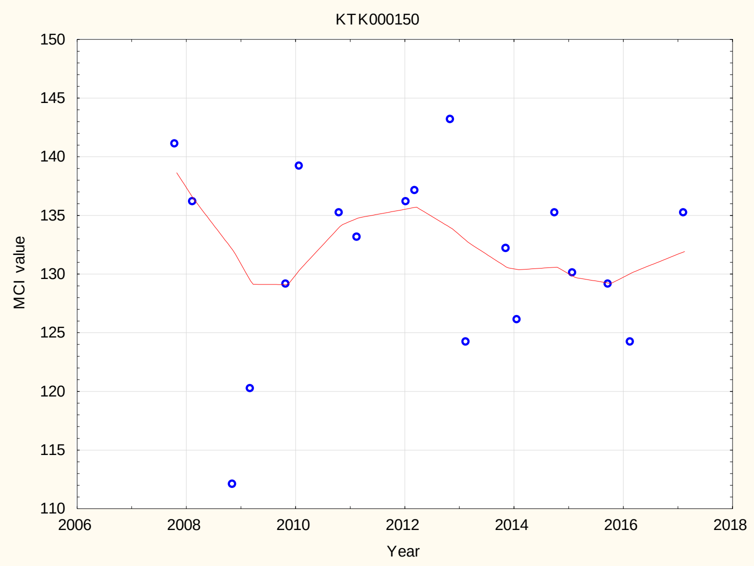
N = 35
Kendall tau = -0.282
p level = 0.017
FDR p = 0.034

Figure 30 LOWESS trend plot of MCI data in the Katikara Stream at the Carrington Road site

Relatively stable MCI scores over the first four years of the period at this pristine site inside the National Park were followed by a very gradual rise. The subsequent significant downward trend (FDR p<0.05) has been due to significant headwater erosion effects during 2008, and subsequent limited recovery. The range of scores found across the trendline (15 units) over the period has been of marginal ecological importance with the range having widened appreciably since the erosion event. However, the trendline was indicative of 'very good' generic stream health (Table 2) throughout the period, bordering on 'excellent' in the 2006-2007 period.

3.2.5.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 31). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Katikara Stream at Carrington Road.



N = 19
Kendall tau = - 0.125
p level = 0.454
FDR p = 0.770

Figure 31 LOWESS trend plot of ten years of MCI data in the Katikara Stream at the Carrington Road site

A negative non-significant trend in MCI scores has been found over the ten year period in contrast to the significant negative result found in the full dataset. The ten year dataset trendline shows a sharp decline from 2007 to 2010 but then has little trend after that date which is slightly at odds with the full dataset as the significant negative decline found in the full dataset was fully encompassed in the ten year dataset. The trendline consistently indicated mostly 'very good' generic river health (Table 2).

3.2.5.2 Coastal site (KTK000248)

3.2.5.2.1 Taxa richness and MCI

Thirty-two surveys have been undertaken in the Katikara Stream at this lower reach site near the coast between October 2000 and March 2016. The exact position of the site has been shifted slightly upstream from the summer 2016 survey onwards to avoid being flooded when the stream outlet blocks during low summer flows. The results of the thirty surveys are summarised in Table 26, together with the results from the current period, and illustrated in Figure 32.

Table 26 Results of previous surveys performed in the Katikara Stream near the coast together summer 2017

Site code	SEM data (2000 to February 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
KTK000248	32	20-31	26	87-118	102	17	102

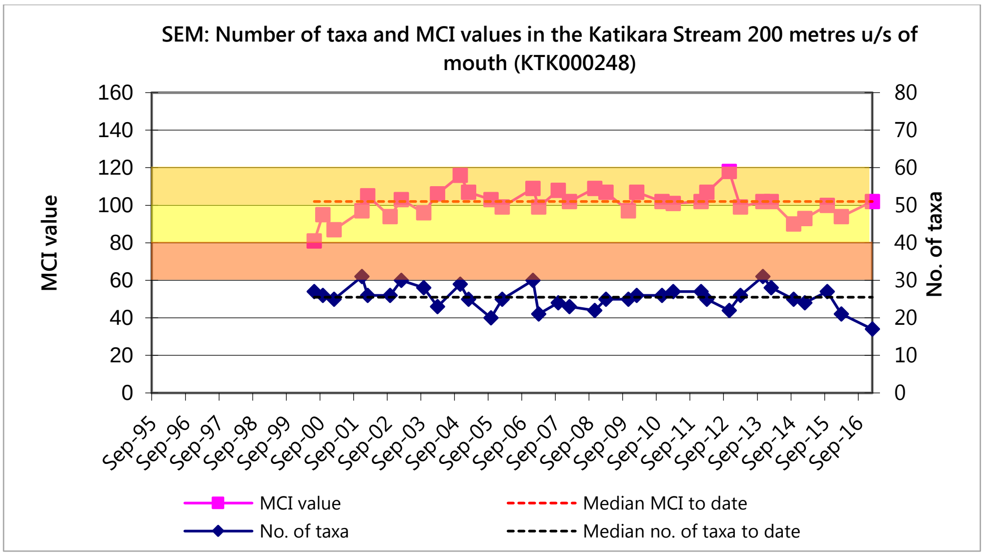


Figure 32 Numbers of taxa and MCI values in the Katikara Stream 200m u/s of the coast

A moderate range of richnesses (20 to 31 taxa) has been found with no obvious indication of the severe effects of headwater erosion events that have been noted at the upstream site. The median richness of 26 taxa has been more representative of typical richnesses elsewhere in the lower reaches of ringplain streams and rivers (TRC, 2016b). During the 2016-2017 period, summer taxa richness (17 taxa) was the lowest recorded richness to date and nine taxa lower than the historical median.

MCI values have had a relatively wide range (31 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (102 units) has been higher than typical of lower reach sites elsewhere on the ringplain however (TRC, 2016b). The summer (102 units) scores was not significantly different from the historical median. The MCI score categorised this site as having 'good' health generically (Table 2). The historical median score (102 units) also placed this site in the 'good' category for generic health.

3.2.5.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 27.

Table 27 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Katikara Stream near the mouth between October 2000 and March 2016 [32 surveys], and by the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
NEMERTEA	Nemertea	3	4			4	12	
ANNELIDA (WORMS)	Oligochaeta	1	11	11	1	23	70	
MOLLUSCA	*Latia*	5	2			2	6	
	Potamopyrgus	4	8	9	12	29	88	
CRUSTACEA	*Paratya*	3	2			2	6	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	15	2		17	52	
	Coloburiscus	7	10	4		14	42	
	Deleatidium	8	9	9	3	21	64	A

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
	Rallidens	9	1			1	3	
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	3			3	9	
	Zelandoperla	8	1			1	3	
COLEOPTERA (BEETLES)	Elmidae	6	7	14	7	28	85	A
	Ptilodactylidae	8	1	1		2	6	
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	17	1		18	55	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	7	16	7	30	91	VA
	Costachorema	7	7			7	21	
	Hydrobiosis	5	20	1		21	64	
	Pycnocentrodes	5	8	10	9	27	82	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	18	4		22	67	
	Maoridiamesa	3	7	4		11	33	A
	Orthocladiinae	2	15	10	1	26	79	A
	Tanytarsini	3	5			5	15	
	Austrosimulium	3	9	1		10	30	

Prior to the current 2016-2017 period, 23 taxa had characterised the community at this site on occasions. These have comprised four ‘highly sensitive’, ten ‘moderately sensitive’, and nine ‘tolerant’ taxa i.e. a minority of ‘highly sensitive’ taxa and an increased proportion of ‘tolerant’ taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included one ‘highly sensitive’ taxon [mayfly (*Deleatidium*)]; six ‘moderately sensitive’ taxa [mayfly (*Austroclima*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)]; and four ‘tolerant’ taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges]. The summer 2017 community consisted of five characteristic taxa that were a mixture of sensitive and tolerant taxa which was reflected in the $SQMCI_s$ score of 4.5 units (Table 27).

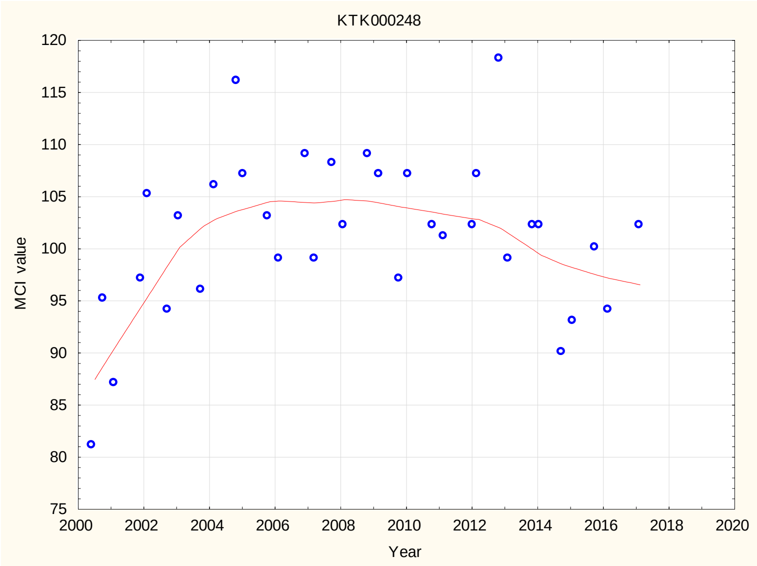
3.2.5.2.3 Predicted stream ‘health’

The Katikara Stream at the site near the coast is 18.1 km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 99 for this site. The historical site median (102) was not significantly different from the distance predictive value. The summer score (102 units) was also not significantly different to predictive values.

The median value for a ringplain stream arising inside the National Park (TRC, 2016b) was 90 units. The historical score was significantly higher (by 12 units) than the TRC, 2016b value and the summer score was also significantly higher. The REC predicted MCI value (Leathwick, et al. 2009) was 96 units. The historical and summer scores were not significantly different to the REC value (Stark, 1998).

3.2.5.2.4 Temporal trends in 2000 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 33). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 17 years of SEM results (2000-2017) from the site in the Katikara Stream near the coast.



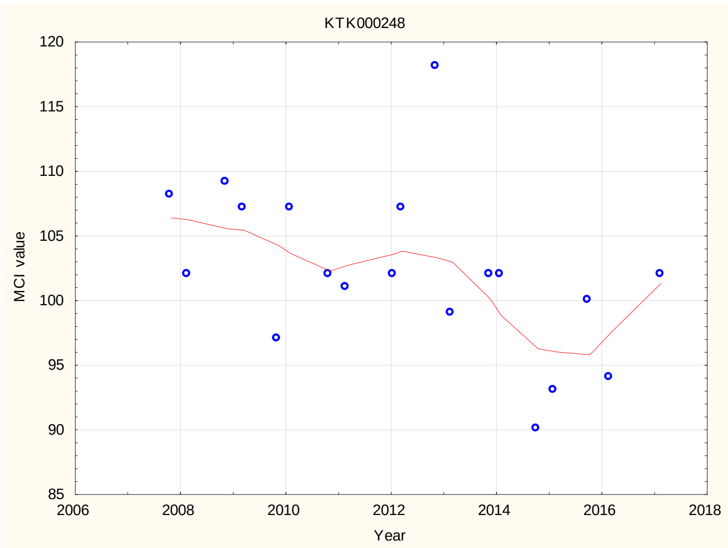
N = 34
Kendall tau = +0.046
p level = 0.704
FDR p = 0.819

Figure 33 LOWESS trend plot of MCI data in the Katikara Stream at the coastal site

The trend over the 17 year period has not been significant (FDR p>0.05). A relatively strong improvement in MCI scores has been recorded from 2000 to 2006 but then plateaued from 2006-2008 before decreasing from 2008 onwards coincident with the headwater erosion event also decreasing MCI scores and taxa richness at the upstream site. There had been a positive significant improvement at the site before the prolonged effects of the headwater erosion event had decreased MCI scores and the wide range of MCI scores (18 units) found throughout the trendline have been of ecological importance coincidentally with retirement and riparian planting of the margins of the lower reaches of this stream. The trendline range of scores indicative of 'fair' generic stream health (Table 2) have improved to 'good' health after 2003 where they remained until a return to 'fair' health most recently.

3.2.5.2.5 Temporal trends in 2006 to 2016 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 34). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Katikara Stream near the coast.



N = 19
Kendall tau = -0.389
p level = 0.020
FDR p = 0.277

Figure 34 LOWESS trend plot of ten years of MCI data in the Katikara Stream at the coastal site

A negative non-significant trend in MCI scores after FDR adjustment has been found over the ten year period in contrast with the positive, but non-significant trend found with the full dataset. The ten year dataset trendline shows a gradual decline throughout the dataset with the trend significant before FDR adjustment whereas the full dataset showed a large improvement before the erosion event negatively affected the macroinvertebrate community. The trendline went from 'good' health to 'fair' health and then back to 'good' health (Table 2).

3.2.5.3 Discussion

The upper and lower sites had relatively low taxa richnesses with the lower site recording its lowest taxa richness to date. This was likely due to habitat deterioration due to headwater erosion

No spring surveys were able to be completed due to persistently high flows. Historically, seasonal median scores (Appendix II) have remained very similar at the National Park site (within two units) and identical at the coastal site. MCI and SQMCIs scores for the upper site indicated 'very good' to 'excellent' macroinvertebrate health while the lower site indicated 'good' to 'fair' health. MCI scores fell in a downstream direction in summer (by 33 units) over a stream distance of 18.1 km downstream from the National Park boundary which was typical for Taranaki ringplain streams. The deterioration in macroinvertebrate health was likely due to nutrient enrichment from cumulative inputs from point and diffuse sources.

Trend analysis indicated that there was a significant long term decrease in MCI scores at the upper site while 10 year trends and lower site trends were all non-significant. MCI scores were typical for both sites with little difference between the current survey and historical medians which contrasts with recent surveys where headwater erosion was attributed to lower scores, especially at the upper site.

3.2.6 Kaupokonui River

The Kaupokonui River is a ringplain river with its source inside Egmont National Park that flows north to south. Five sites located along the length of the Kaupokonui River were included in the SEM programme, commencing in the 1999-2000 year for the purpose of long term monitoring of the impacts of riparian vegetation planting initiatives throughout this catchment. Two sites, at Opunake Road (KPK000250) and near the coast (KPK000990), were established specifically for this purpose, while the remaining three sites were components of existing consent monitoring programmes.

The results of the spring 2016 and summer 2017 surveys are presented in Table 136 and Table 137, Appendix I.

3.2.6.1 Opunake Road site (KPK000250)

3.2.6.1.1 Taxa richness and MCI

Thirty-five surveys have been undertaken in the Kaupokonui River at this upper mid-reach site at Opunake Road (draining relatively open farmland approximately 3.3 km downstream of the National Park) between March 1998 and February 2016. These results are summarised in Table 28, together with the results from the current period, and illustrated in Figure 35.

Table 28 Results of previous surveys performed in the Kaupokonui River at Opunake Road, together with spring 2016 and summer 2017 results

Site code	SEM data (1998 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000250	35	20-36	27	124-138	130	28	129	22	136

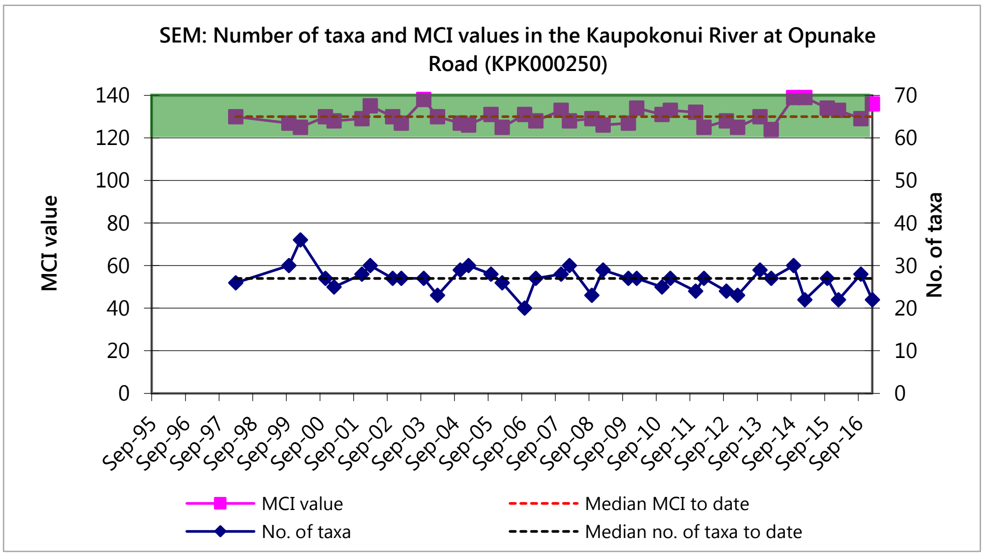


Figure 35 Numbers of taxa and MCI values in the Kaupokonui River at Opunake Road

A relatively wide range of richnesses (20 to 36 taxa) has been found; wider than might be expected, with a median richness of 27 taxa (more representative of typical richnesses in the upper mid-reaches of ringplain streams and rivers). During the 2016-2017 period spring (28 taxa) and summer (22 taxa) richnesses were relatively similar to the historic median.

MCI values have had a narrow range (14 units) at this site, more typical of sites in the upper reaches of ringplain rivers. The median value (130 units) has been higher than typical of mid-reach sites elsewhere on the ringplain. The spring 2016 (129 units) and summer 2017 (136 units) scores were very similar to each other and non-significantly different to the historic median. These scores categorised this site as having ‘very good’, (spring and summer) health generically (Table 2). The historical median score (129 units) placed this site in the ‘very good’ category for generic health.

3.2.6.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 29.

Table 29 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Kaupokonui River at Opunake Road between 1995 and February 2016 [35 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	2			2	6		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	3			3	9		
	Coloburiscus	7	12	15	6	33	94	A	A
	Deleatidium	8	1	13	21	35	100	VA	XA
	Nesameletus	9	12	5		17	49		
PLECOPTERA (STONEFLIES)	*Acroperla*	5	1			1	3		
	Megaleptoperla	9	20	1		21	60		A
	Zelandoperla	8	20	12		32	91	A	VA
COLEOPTERA (BEETLES)	Elmidae	6	12	21	1	34	97	A	A
	Hydraenidae	8	3			3	9		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	7			7	20		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	17	12		29	83		VA
	Costachorema	7	5			5	14		
	Hydrobiosis	5	3	1		4	11		
	Beraeoptera	8	12	12	2	26	74	A	
	Helicopsyche	10	4	1		5	14	A	
	Olinga	9	11	9	3	23	66	A	VA
	Pycnocentrodes	5	9	4		13	37		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	17	16		33	94		VA
	Eriopterini	5	6			6	17		
	Maoridiamesa	3	6	1		7	20		
	Orthocladiinae	2	6	2		8	23		

Prior to the current 2016-2017 period, 22 taxa had characterised the community at this site on occasions. These have comprised eight ‘highly sensitive’, ten ‘moderately sensitive’, and four ‘tolerant’ taxa i.e. a majority of ‘sensitive’ taxa as would be expected in the upper mid-reaches of a ringplain stream. Predominant taxa have included five ‘highly sensitive’ taxa [mayfly (*Deleatidium*, on every sampling occasion), stoneflies (*Megaleptoperla* and *Zelandoperla*), and cased caddisflies (*Beraeoptera* and *Olinga*)]; three ‘moderately sensitive’ taxa [mayfly (*Coloburiscus*), elmid beetles, and cranefly (*Aphrophila*)]; and one ‘tolerant’ taxon [net-building caddisfly (*Hydropsyche-Aoteapsyche*)]. The spring 2016 community consisted of seven characteristic taxa that were all sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.6

units. The summer 2017 community consisted of eight characteristic taxa that were mostly sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.3 units indicating excellent macroinvertebrate health (Table 136 and Table 137).

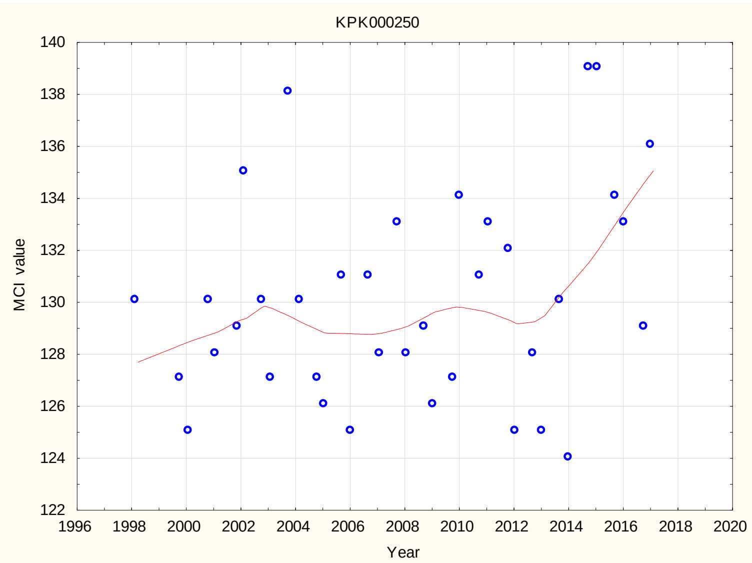
3.2.6.1.3 Predicted stream 'health'

The Kaupokonui River site at Opunake Road is 3.3 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 118 for this site. The historical site median (130) is significantly higher (Stark, 1998) by 12 units than the distance predictive value. The spring 2016 score (129 units) and summer score (136 units) were both significantly higher than the distance value.

The median value for a ringplain stream arising outside the National Park (TRC, 2016b) was 130 units. The historical, spring and summer scores were not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 137 units. The historical, spring and summer scores were also not significantly different to the REC value either (Stark, 1998).

3.2.6.1.4 Temporal trends in 1998 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 36). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 19 years of SEM results (1998-2017) from the site in the Kaupokonui River at Opunake Road.



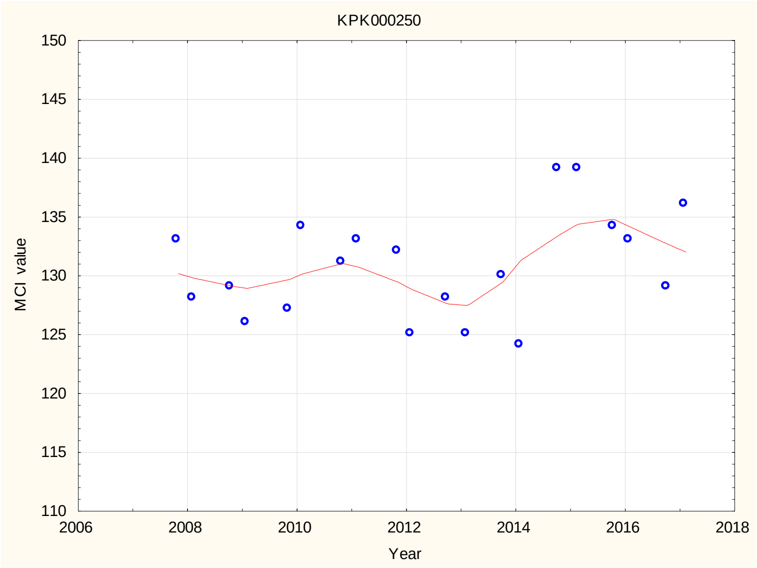
N = 37
Kendall tau = +0.161
p level = 0.161
FDR p = 0.241

Figure 36 LOWESS trend plot of MCI data in the Kaupokonui River at the Opunake Road site

MCI scores have not been statistically significant at this site in the upper mid-reaches of the river over the 19 year monitoring period. The LOWESS-smoothed range of scores (seven units) has been narrow and not ecologically important. Smoothed MCI scores were continuously indicative of 'very good' generic river health (Table 2).

3.2.6.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 37). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Kaupokonui River at Opunake Road.



N = 20
Kendall tau = +0.172
p level = 0.289
FDR p = 0.558

Figure 37 LOWESS trend plot of ten years of MCI data in the Kaupokonui River at the Opunake Road site

The positive, non-significant trend was congruent with that found for the full dataset. The trendline has inhabited a narrow range of scores suggesting little change and was indicative of 'very good' generic river health (Table 2).

3.2.6.2 Site upstream of the Kaponga oxidation ponds system (KPK000500)

3.2.6.2.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Kaupokonui River at this mid-reach site at the site upstream of the Kaponga oxidation ponds system between February 1996 and February 2016. These results are summarised in Table 30, together with the results from the current period, and illustrated in Figure 38.

Table 30 Results of previous surveys performed in the Kaupokonui River at the site upstream of the Kaponga oxidation ponds system together with spring 2016 and summer 2017 results

Site code	SEM data (1996 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000500	38	20-33	26	98-133	117	20	105	27	113

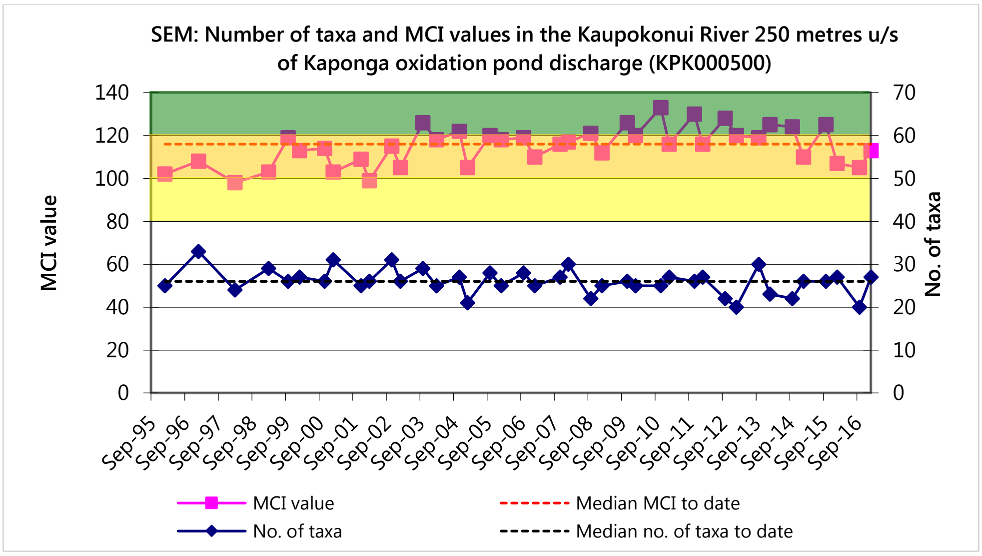


Figure 38 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kaponga oxidation pond system

A moderate range of richnesses (20 to 33 taxa) has been found with a median richness of 26 taxa, typical of richnesses in the mid reaches of ringplain streams and rivers. During the 2016-2017 period, spring (20 taxa) and summer (27 taxa) richnesses were very similar to each other and to the historic median.

MCI values have had a relatively wide range (35 units) at this site, slightly wider than typical of sites in the mid-reaches of ringplain rivers. The median value (117 units) has been very slightly higher than typical of mid-reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (105 units) was significantly lower than the median but the summer 2017 (113 units) score was not significantly different (Stark, 1998). The MCI scores categorised this site as having 'good' (spring and summer) health generically (Table 2). The historical median score (117 units) placed this site in the 'good' category for generic health.

3.2.6.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 31.

Table 31 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Kaupokonui River upstream of the Kaponga oxidation ponds system between 1995 and February 2016 [38 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	2			2	5		
ANNELIDA (WORMS)	Oligochaeta	1	4	1	1	6	16		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	5	1		6	16		
	Coloburiscus	7	11	14	11	36	95		A
	Deleatidium	8	3	6	24	33	87		XA
	Nesameletus	9	12	7	1	20	53		A

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	1			1	3		
	Zelandoperla	8	9			9	24		
COLEOPTERA (BEETLES)	Elmidae	6	18	16	1	35	92		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	19	1		20	53		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	16	14	4	34	89		VA
	Costachorema	7	18	1		19	50		A
	Hydrobiosis	5	7	4		11	29		A
	Beraeoptera	8	11	7	2	20	53		
	Olinga	9	5			5	13		
	Oxyethira	2	1			1	3		
	Pycnocentrodes	5	10	10	2	22	58		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	19	18		37	97		
	Eriopterini	5	5			5	13		
	Maoridiamesa	3	9	8	9	26	68	A	XA
	Orthocladiinae	2	12	9	3	24	63	XA	A
	Tanytarsini	3	3	3		6	16		
	Empididae	3	1			1	3		
	Muscidae	3	4			4	11		
	Austrosimulium	3	1			1	3		

Prior to the current 2016-2017 period, 25 taxa had characterised the community at this site on occasions. These have comprised six 'highly sensitive', nine 'moderately sensitive', and ten 'tolerant' taxa i.e. a majority of 'sensitive' taxa but a small downstream increase in 'tolerant' taxa compared with the Opunake Road site, as would be expected in the mid-reaches of a ringplain river. Predominant taxa have included three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*) and flare-cased caddisfly (*Beraeoptera*)]; six 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Costachorema*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [free-living caddisfly (*Hydropsyche-Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)]. The spring 2016 community consisted of two characteristic taxa comprising two tolerant taxa which was reflected in the low $SQMCI_s$ score of 2.4 units which indicated 'very poor' health. The summer 2017 community consisted of eight characteristic taxa which were a mixture of tolerant and sensitive taxa which was reflected in the moderate $SQMCI_s$ score of 5.2 units which indicated 'good' health (Table 31) (Table 136 and Table 137).

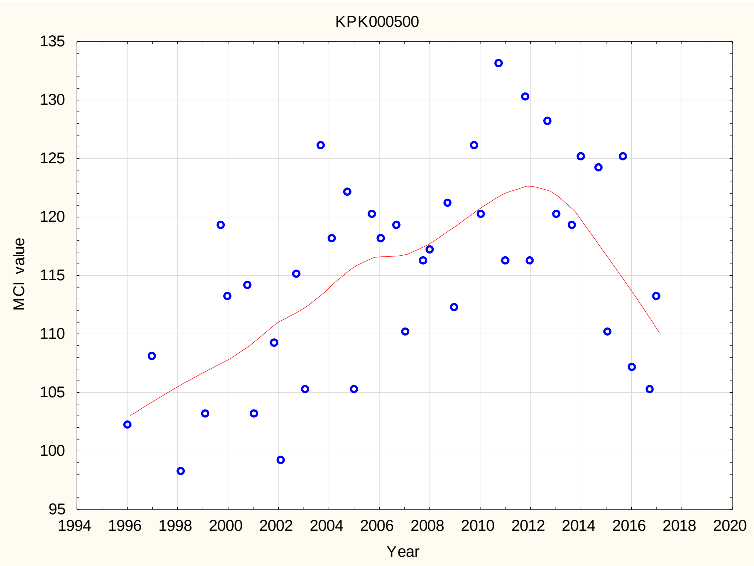
3.2.6.2.3 Predicted stream 'health'

The Kaupokonui River site upstream of the Kaponga oxidation pond system is 9.2 km downstream of the National Park boundary at an altitude of 260 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 107 for this site. The historical site median (117) is ten units higher than the distance predictive value. The spring 2016 (105 units) and summer 2017 (113 units) scores were not significantly different to the predictive value.

The median value for a ringplain stream arising outside the National Park (TRC, 2016b) was 113 units. The historical, spring and summer scores were not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 127 units. The historical score was not significantly different to the REC value but the spring and summer scores were significantly lower (Stark, 1998).

3.2.6.2.4 Temporal trends in 1996 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 39). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 21 years of SEM results (1996-2017) from the site in the Kaupokonui River upstream of the Kaponga oxidation ponds system.



N = 40
Kendall tau = +0.309
p level = 0.005
FDR p = 0.011

Figure 39 LOWESS trend plot of MCI data at the site in the Kaupokonui River upstream of the Kaponga oxidation ponds system

A significant trend in MCI scores has been found over the 21 year period (FDR p<0.05). The range of trendline scores (20 units) has been of some ecological importance over the period though that importance has been recently decreasing. Improvements may have been related partly to improved dairyshed wastes disposal consents' compliance reported in this catchment. Trendline scores consistently indicated 'good' generic river health with a brief period of 'very good' health from 2010-2014 (Table 2).

3.2.6.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 40). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Kaupokonui River upstream of the Kaponga oxidation ponds system.

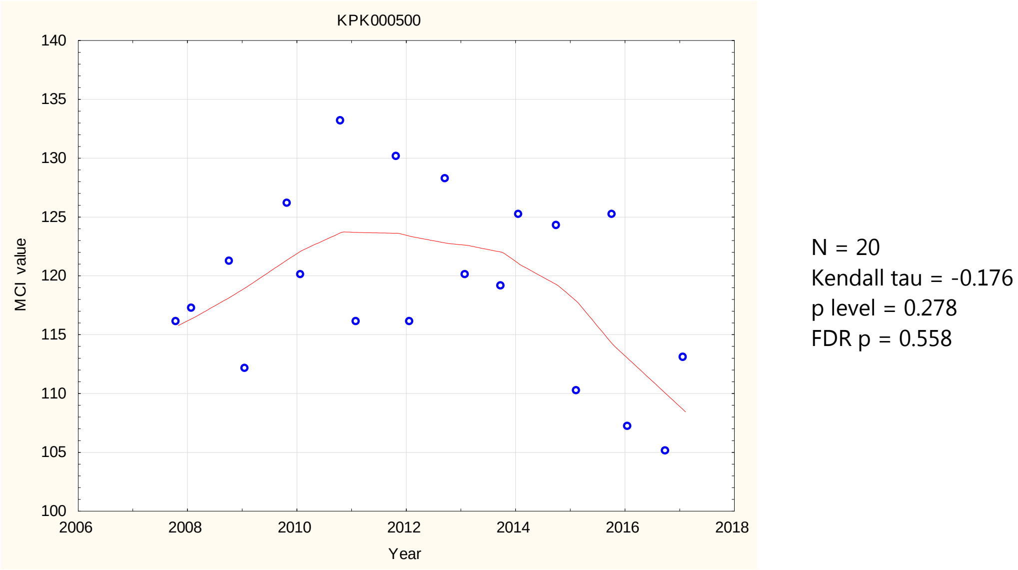


Figure 40 LOWESS trend plot of ten years of MCI data in the Kaupokonui River at the site upstream of the Kaponga oxidation ponds system

A slightly negative, non-significant trend in MCI scores has been found over the ten year period in contrast to the significant positive result found in the full dataset. The ten year results show an increasing trend for the earlier part of the ten year period before the trend decreases after 2012. The trendline indicated 'good' to 'very good' generic river health (Table 2).

3.2.6.3 Site upstream of Kapuni railbridge (KPK000660)

3.2.6.3.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Kaupokonui River at this mid-reach site upstream of the Kapuni railbridge between December 1995 and February 2016. These results are summarised in Table 32, together with the results from the current period, and illustrated in Figure 41.

Table 32 Results of previous surveys performed in the Kaupokonui River upstream of Kapuni railbridge, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000660	38	15-32	24	71-128	103	26	109	23	103

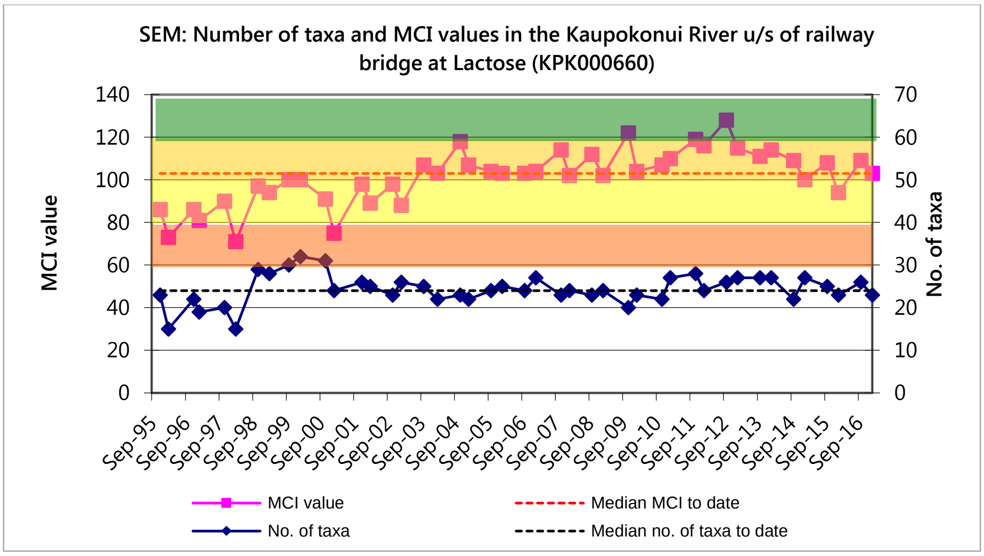


Figure 41 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kapuni railbridge

A wide range of richnesses (15 to 32 taxa) has been found with a median richness of 24 taxa (more representative of typical richnesses in the mid reaches of ringplain streams and rivers). During the 2016-2017 period spring (26 taxa) and summer (23 taxa) richnesses were relatively similar to each other and the historic median.

MCI values have had a very wide range (57 units) at this site, much wider than typical of sites elsewhere in the mid reaches of ringplain rivers. However, the median value (103 units) has been relatively typical of mid reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (109 units) and summer 2017 (103 units) scores were not significantly different from each other and to the historic median (Stark, 1998).

These scores categorised this site as having 'good' (spring and summer) health generically (Table 2). The historical median score (103 units) placed this site in the 'good' category for generic health.

3.2.6.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 33.

Table 33 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Kaupokonui River upstream of Kapuni railbridge between 1995 and February 2016 [38 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	8	1		9	21		
ANNELIDA (WORMS)	Oligochaeta	1	13	2	5	20	48		
	Lumbricidae	5	1			1	2		
MOLLUSCA	*Potamopyrgus*	4	6	4		10	24		
CRUSTACEA	Ostracoda	1	1			1	2		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	4			4	10		
	Coloburiscus	7	14	10		24	57	VA	A

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
	Deleatidium	8	6	9	16	31	74	VA	XA
	Nesameletus	9	2			2	5		
PLECOPTERA (STONEFLIES)	*Acroperla*	5	1			1	2		
HEMIPTERA (BUGS)	*Sigara*	3	1			1	2		
COLEOPTERA (BEETLES)	Elmidae	6	5	23	7	35	83	A	VA
	Hydraenidae	8	2			2	5		A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	21	1		22	52	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	8	10	7	25	60	A	VA
	Costachorema	7	8			8	19		
	Hydrobiosis	5	16			16	38		
	Beraeoptera	8	5	1		6	14		
	Olinga	9	2			2	5		
	Oxyethira	2	7			7	17		
	Pycnocentrodes	5	5	5		10	24	VA	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	19	5		24	57	A	
	Eriopterini	5	1			1	2		
	Chironomus	1		1		1	2		
	Maoridiamesa	3	15	5	4	24	57	VA	
	Orthocladiinae	2	18	11	3	32	76	VA	
	Tanytarsini	3	6			6	14	A	
	Empididae	3	2			2	5		
	Muscidae	3	2			2	5		
	Austrosimulium	3	5			5	12		

Prior to the current 2016-2017 period, 30 taxa had characterised the community at this site on occasions. These have comprised five 'highly sensitive', eleven 'moderately sensitive', and ten 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a higher proportion of 'tolerant' taxa as might be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; three 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. The spring 2017 community consisted of ten characteristic taxa with a SQMCIs score of 5.1 units indicating 'good' macroinvertebrate health. The summer 2017 community consisted of six characteristic taxa with a SQMCIs score of 7.1 units indicating 'excellent' macroinvertebrate health (Table 33) (Table 136 and Table 137).

3.2.6.3.3 Predicted stream 'health'

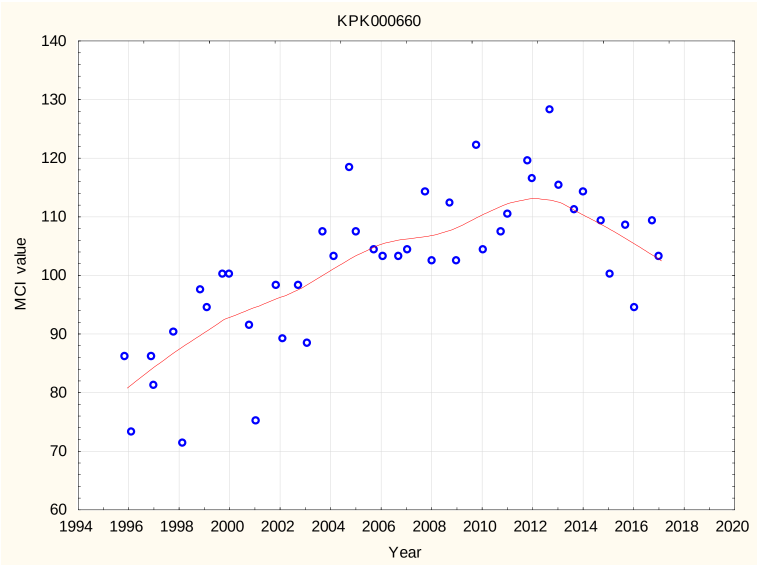
The Kaupokonui River site upstream of the Kapuni railbridge is 15.5 km downstream of the National Park boundary at an altitude of 170 m asl. Relationships for ringplain streams developed between MCI and and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value of 101 for this site.

The historical site median (103) is two units above the distance predictive value. The spring 2016 (109 units) and summer 2017 (103 units) scores were not significantly different to the predictive value.

The median value for a ringplain stream arising inside the National Park (TRC, 2016b) was 108 units. The historical, spring and summer scores were not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 122 units. The historical, spring and summer scores were all significantly lower than the REC value (Stark, 1998).

3.2.6.3.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 42). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Kaupokonui River upstream of the Kapuni railbridge.



N = 44
Kendall tau = +0.510
p level < 0.001
FDR p < 0.001

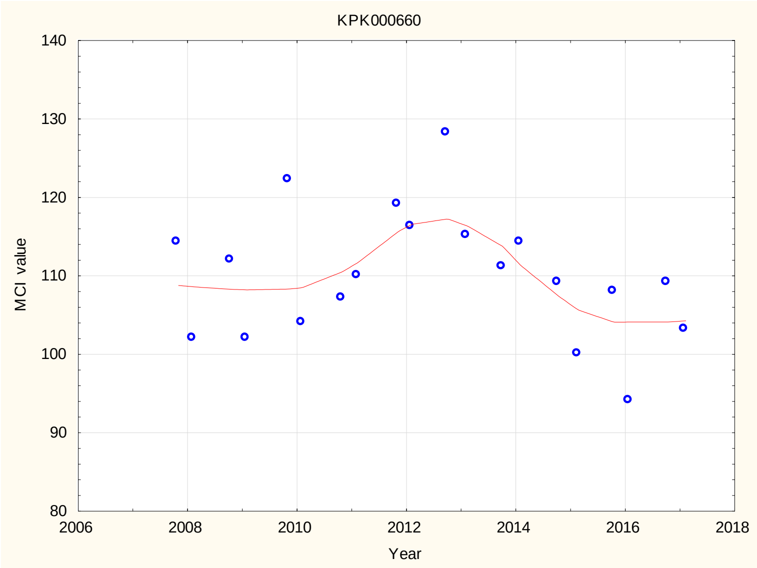
Figure 42 LOWESS trend plot of MCI data in the Kaupokonui River at the site upstream of Kapuni railbridge

A highly significant improvement in MCI scores has been found over a 22 year period at this mid-catchment site (FDR p<0.01). This trendline has a wide range (33 units) which has been ecologically very important. Fonterra factory wastewater irrigation activities nearby in this catchment have been better managed during this period and surveillance monitoring has reported improved dairy shed waste treatment ponds systems compliance upstream of this site.

The trend in generic river health (Table 2) has moved from 'poor' to 'fair' during the first half of the period, improving to 'good' where it has remained since 2003. However, since 2012 the MCI scores have declined and if this continues the trendline will fall back into the 'fair' category.

3.2.6.3.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 43). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Kaupokonui River upstream of the Kapuni railbridge.



N = 20
Kendall tau = -0.175
p level = 0.280
FDR p = 0.558

Figure 43 LOWESS trend plot of ten years of MCI data in the Kaupokonui River at the site upstream of Kapuni railbridge

A slightly negative non-significant trend in MCI scores has been found over the ten year period in contrast to the highly significant positive result found in the full dataset. The ten year results show an increasing trend for the earlier part of the ten year period before the trend sharply decreases after 2013. The trendline consistently indicated 'good' generic river health (Table 2).

3.2.6.4 Upper Glenn Road site (KPK000880)

3.2.6.4.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Kaupokonui River at this lower reach site at Upper Glenn Road between 1995 and February 2016. These results are summarised in Table 34, together with the results from the current period, and illustrated in Figure 44.

Table 34 Results of previous surveys performed in the Kaupokonui River at Upper Glenn Road, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000880	42	14-31	19	66-110	91	18	99	20	102

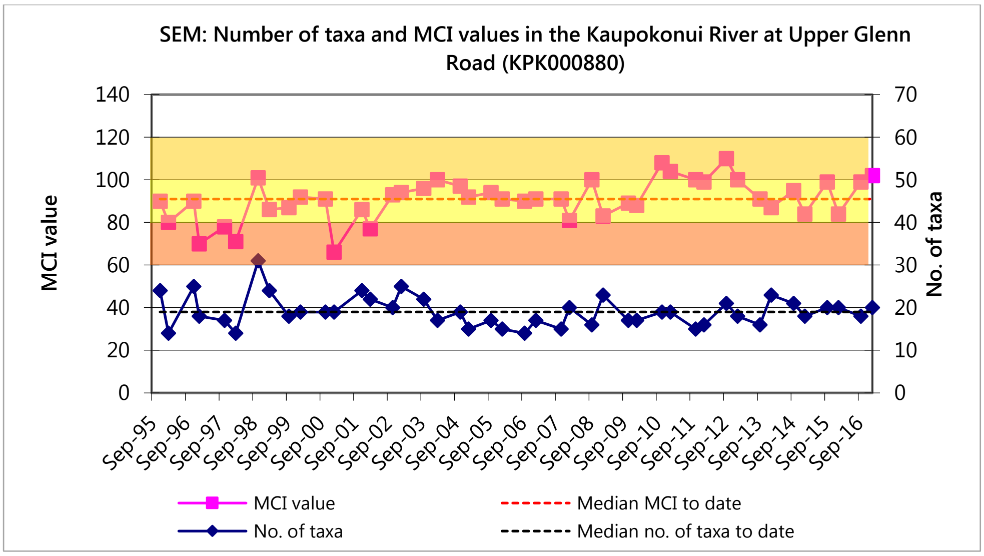


Figure 44 Numbers of taxa and MCI values in Kaupokonui River at Upper Glenn Road

A wide range of richnesses (14 to 31 taxa) has been found with a median richness of 19 taxa (typical of richnesses in the lower reaches of ringplain streams and rivers). During the 2016-2017 period spring (18 taxa) and summer (20 taxa) richnesses were similar to each other and to the historic median taxa number.

MCI values have had a very wide range (44 units) at this site, more typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been slightly lower than typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (99 units) and summer 2017 (102 units) scores were not significantly different from the historical median score. These scores categorised this site has having 'fair' (spring) and 'good' (summer) generically (Table 2). The historical median score (91 units) placed this site in the 'fair' category for generic health.

3.2.6.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 35.

Table 35 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Kaupokonui River at Upper Glenn Road between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	1			1	2		
NEMERTEA	Nemertea	3	5	1		6	14		
ANNELIDA (WORMS)	Oligochaeta	1	20	10	5	35	83	A	
MOLLUSCA	*Latia*	5	1			1	2		
	Physa	3	2			2	5		
	Potamopyrgus	4	6	6	2	14	33		
CRUSTACEA	Ostracoda	1	1			1	2		
	Paracalliope	5	1			1	2		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	1			1	2		

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
	Coloburiscus	7	3			3	7		
	Deleatidium	8	8	8	7	23	55	XA	XA
	Nesameletus	9	1			1	2		
COLEOPTERA (BEETLES)	Elmidae	6	8	16	4	28	67	A	
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	5	1		6	14		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	7	13	5	25	60		VA
	Costachorema	7	3			3	7		
	Hydrobiosis	5	19	4		23	55	A	
	Oxyethira	2	7			7	17		
	Pycnocentrodes	5	11	7	4	22	52	VA	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	6	1		7	17		
	Chironomus	1			1	1	2		
	Maoridiamesa	3	13	9	3	25	60	VA	A
	Orthocladiinae	2	17	13	8	38	90	A	VA
	Tanytarsini	3	6			6	14	A	
	Ephydridae	4	1			1	2		
	Muscidae	3	3			3	7		
	Austrosimulium	3	2			2	5		

Prior to the current 2016-2017 period, 27 taxa had characterised the community at this site on occasions. These have comprised two 'highly sensitive', ten 'moderately sensitive', and fifteen 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [elmid beetles and caddisfly (*Hydrobiosis*)]; and four 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. The spring 2016 community consisted of eight characteristic taxa that were a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 6.4 units that indicated 'very good' health. The summer 2017 community consisted of four characteristic taxa that were a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 6.4 units that indicated 'very good' health (Table 33) (Table 136 and Table 137).

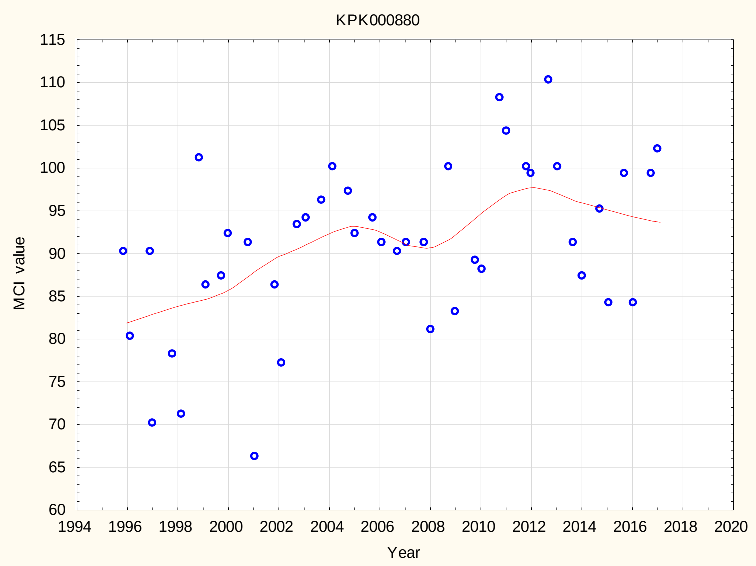
3.2.6.4.3 Predicted stream 'health'

The Kaupokonui River site at Upper Glenn Road is 25.7 km downstream of the National Park boundary at an altitude of 60 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value of 95 for this site. The historical site median (91) is four units lower than the predictive distance value. The spring 2016 score (99 units) and the summer 2016 score (102 units) were similar to predictive values.

The median value for a ringplain stream arising inside the National Park (TRC, 2016b) was 98 units. The historical, spring and summer scores were not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 106 units. The historical score was significantly lower than the REC value but the spring and summer scores were not significantly different (Stark, 1998).

3.2.6.4.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 45). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Kaupokonui River at Upper Glenn Road.



N = 44
Kendall tau = +0.289
p level = 0.006
FDR p = 0.013

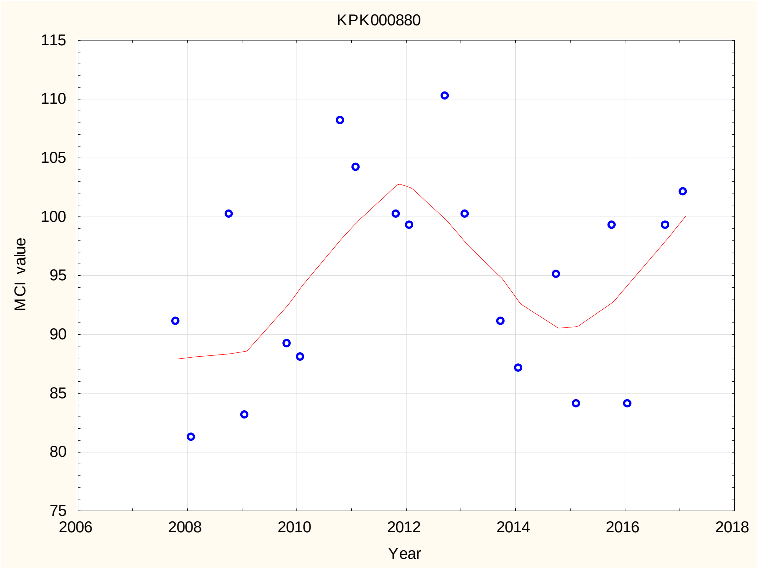
Figure 45 LOWESS trend plot of MCI data in the Kaupokonui River at the Upper Glenn Road site

A significant improvement in MCI scores was found at this site (FDR p<0.05). There has mostly been an increasing trend up until 2012 with one small dip from 2005-2008. However, the trend has declined in the past five years. The trendline range of MCI scores (15 units) has been ecologically important but nowhere near as wide as that upstream, indicative of some decrease in effects in a downstream direction. The overall positive trend was due to improved wastes management further upstream in the catchment but more particularly in relation to a reduction in heat input (via cooling water) to the river at the Fonterra, Kapuni factory.

The trendline MCI scores have consistently indicated 'fair' generic river health (Table 2) throughout the period.

3.2.6.4.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 46). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Kaupokonui River at Upper Glenn Road.



N = 20
Kendall tau = +0.065
p level = 0.691
FDR p = 0.860

Figure 46 LOWESS trend plot of ten years of MCI data in the Kaupokonui River at the Upper Glenn Road site

A slightly positive, non-significant trend in MCI scores has been found over the ten year period in contrast to the significant positive result found in the full dataset. The ten year results show an increasing trend for the earlier part of the ten year period before the trend sharply decreases after 2012 before an increase from 2015 onwards. The trendline indicated mostly 'fair' generic river health (Table 2).

3.2.6.5 Kaupokonui Beach site (KPK000990)

3.2.6.5.1 Taxa richness and MCI

Thirty-four surveys have been undertaken in the Kaupokonui River at this lower reach site at Kaupokonui Beach between 1999 and February 2016. These results are summarised in Table 36, together with the results from the current period, and illustrated in Figure 47.

Table 36 Results of previous surveys performed in the Kaupokonui River at the Kaupokonui Beach site, together with spring 2016 and summer 2017 results

Site code	SEM data (1999 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000990	34	11-26	19	69-103	91	18	90	18	97

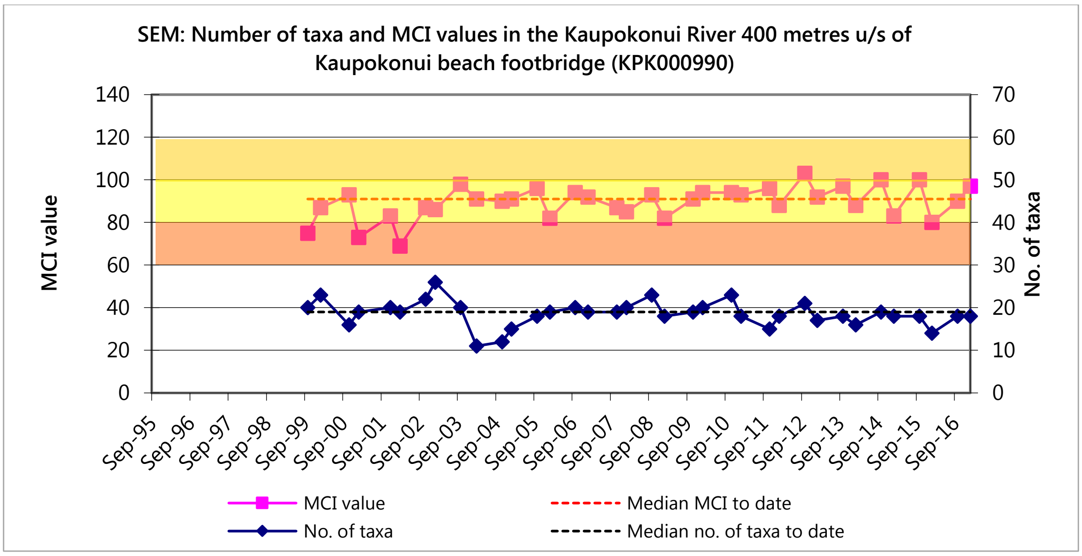


Figure 47 Numbers of taxa and MCI values in the Kaupokonui River at the Kaupokonui Beach site

A wide range of richnesses (11 to 26 taxa) has been found, with a median richness of 19 taxa. During the 2016-2017 period spring (18 taxa) and summer (18 taxa) richnesses were the same and only one taxon lower than the historical the median richness.

MCI values have had a moderate range (34 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (90 units) and summer 2017 (97 units) scores were not significantly different from the historic median. The MCI scores categorised this site as having 'fair' (spring and summer) health generically (Table 2). The historical median score (91 units) placed this site in the 'fair' category for generic health.

3.2.6.5.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 37.

Table 37 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Kaupokonui River at the Kaupokonui Beach site between 1999 and February 2016 [34 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	3	1		4	12		
ANNELIDA (WORMS)	Oligochaeta	1	11	11	10	32	94	A	
MOLLUSCA	*Potamopyrgus*	4	8	9	1	18	53		A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	2			2	6		
	Coloburiscus	7	1			1	3		
	Deleatidium	8	11	9	3	23	68	VA	A
COLEOPTERA (BEETLES)	Elmidae	6	6	12		18	53		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	9	8	4	21	62	A	VA

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
	Costachorema	7	3			3	9		
	Hydrobiosis	5	19			19	56	A	
	Pycnocentrodes	5	9	7	6	22	65	VA	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	2			2	6		
	Maoridiamesa	3	7	11	4	22	65	VA	A
	Orthocladiinae	2	7	12	12	31	91	A	VA
	Tanytarsini	3	11	1		12	35	A	A
	Muscidae	3	1			1	3		

Prior to the current 2016-2017 period, 16 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', seven 'moderately sensitive', and eight 'tolerant' taxa i.e. a very low proportion of 'highly sensitive' taxa and a higher proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; three 'moderately sensitive' taxa [elmid beetles, free-living caddisfly (*Hydrobiosis*), and stony-cased caddisfly (*Pycnocentrodes*)]; and five 'tolerant' taxa [oligochaete worms, snail (*Potamopygus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. The spring 2016 community consisted of eight characteristic taxa comprising a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 4.8 units which indicated 'fair' macroinvertebrate health. The summer 2017 community consisted of seven characteristic taxa comprising a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 3.7 units which indicated 'poor' macroinvertebrate health (Table 37) (Tables 162 and 163).

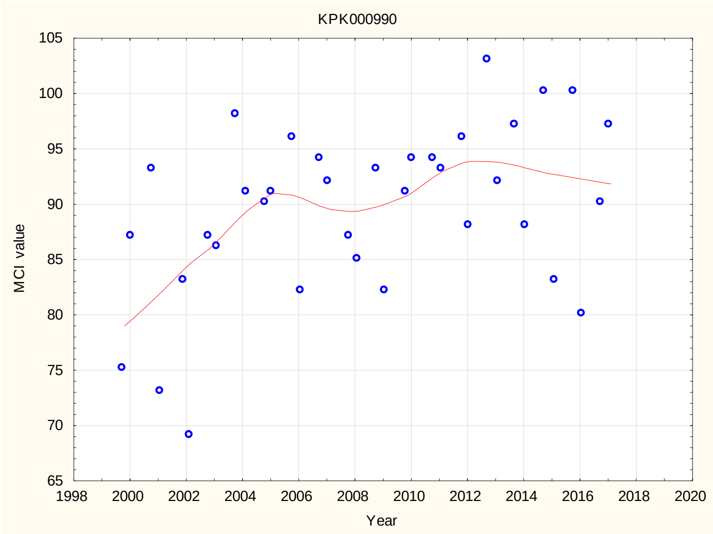
3.2.6.5.3 Predicted stream 'health'

The Kaupokonui River at the Kaupokonui Beach site is 31.1 km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams and rivers developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 93 for this site. The historical site median (91) is two units below the distance predictive value. The spring 2016 (90 units) and summer 2017 (97 units) scores were not significantly different to the distance value.

The median value for a ringplain stream arising inside the National Park (TRC, 2016b) was 90 units. The historical, spring and summer scores were not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 96 units. The historical, spring and summer scores were also not significantly different to the REC value (Stark, 1998).

3.2.6.5.4 Temporal trends in 1999 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 48). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 18 years of SEM results (1999-2017) from the site in the Kaupokonui River at Kaupokonui Beach.



N = 36
Kendall tau = +0.294
p level = 0.012
FDR p = 0.023

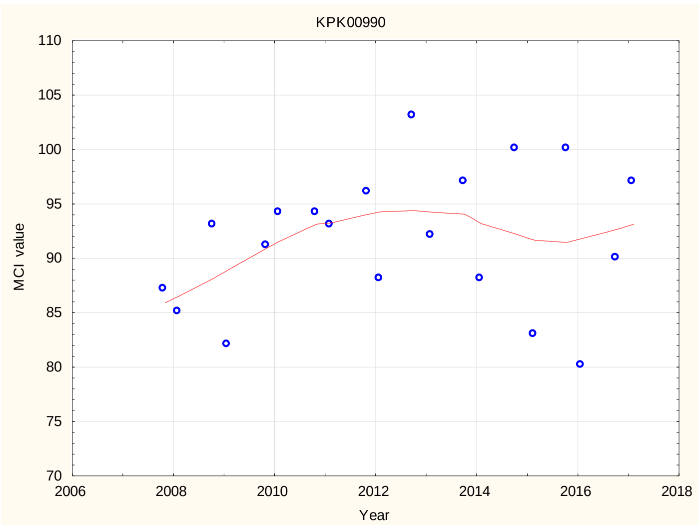
Figure 48 LOWESS trend plot of MCI data in the Kaupokonui River at the Kaupokonui Beach site

There was a significant positive improvement over the 18-year time period (FDR p < 0.05) which showed a similar pattern to that of the site immediately upstream (KPK000880). The moving average has largely increased since 1999 to 2012 apart from a small dip from 2005-2008. Since 2012, the trend has started to decline. The trendline had an ecologically important range of scores (14 units), although much narrower than ranges at the two nearest upstream sites, possibly reflecting certain upstream improvements in waste disposal management (documented earlier) which have had reduced impacts with greater distance downstream.

The trendline range has been indicative of 'fair' generic river health throughout the period (Table 2).

3.2.6.5.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 49). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Kaupokonui River at Kaupokonui Beach.



N = 20
Kendall tau = +0.176
p level = 0.278
FDR p = 0.558

Figure 49 LOWESS trend plot of MCI data in the Kaupokonui River at the Kaupokonui Beach site

A slightly positive, non-significant trend in MCI scores has been found over the ten-year period in contrast to the significant positive result found in the full dataset. The ten-year results show an increasing trend for the earlier part of the ten year period before the trend tapers off after 2013. The trendline consistently indicated mostly 'fair' generic river health (Table 2).

3.2.6.6 Discussion

Sites along the Kaupokonui Stream had moderate taxa richnesses which were similar to historic medians.

MCI and $SQMCI_s$ scores indicated 'very good' to 'excellent' health for the upper site. The second most upstream site had a 'good' MCI score but an abundance of 'tolerant' midges caused a low $SQMCI_s$ score during the spring survey which indicated 'very poor' health. This was coupled with widespread *Phormidum* mats which indicated that there had been significant nutrient enrichment at the site preceding the spring survey. MCI and $SQMCI_s$ scores were typical for the lower three sites with most indices indicating 'good' health for the lower middle two sites with the lowest site having the consistently lowest scores indicating 'fair' health. MCI scores typically fall in a downstream direction between the upper site and the furthest downstream lower reaches site by 39 units over a river distance of 27.8 km. The general deterioration in macroinvertebrate health was likely due to nutrient enrichment from cumulative inputs from point and diffuse sources. Changes in gradient, temperature, substrate sizes and shading from riparian vegetation would also contribute to poorer macroinvertebrate community health and increase the effects of nutrient enrichment.

Time trend analysis showed the majority of sites had significant positive trends over the full dataset indicating that macroinvertebrate communities have been getting healthier over time. However, there were no significant trends over the most recent ten-year period. All sites, except the most upstream site, showed a decreasing trendline from 2012-2013 onwards indicating that improvements in macroinvertebrate communities have plateaued and suggesting that they actually may be getting worse.

3.2.7 Kurapete Stream

The Kurapete Stream is a ringplain seepage-sourced stream running in an easterly direction that flows into the Manganui River which is a tributary of the Waitara River. Two sites, one located immediately upstream of the Inglewood Wastewater Treatment Plant (WWTP) and the other nearly six km downstream, were included in the SEM programme for the purposes of long term monitoring of the impacts of the removal of the treated wastewater discharge from the stream and also, riparian vegetation planting initiatives in the catchment.

Due to persistently high flows no spring 2016 survey was able to be completed. The results of the summer 2017 survey are presented in Table 138, Appendix 1.

3.2.7.1 Site upstream of Inglewood WWTP (KRP000300)

3.2.7.1.1 Taxa richness and MCI

Forty-three surveys have been undertaken, between 1995 and February 2016, at this mid-reach, shaded site, draining developed farmland, downstream of Inglewood, but immediately upstream of the WWTP. These results are summarised in Table 38, together with the results from the current period, and illustrated in Figure 50.

Table 38 Results of previous surveys performed in the Kurapete Stream upstream of Inglewood WWTP, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
KRP000300	43	13-32	22	80-106	94	22	98

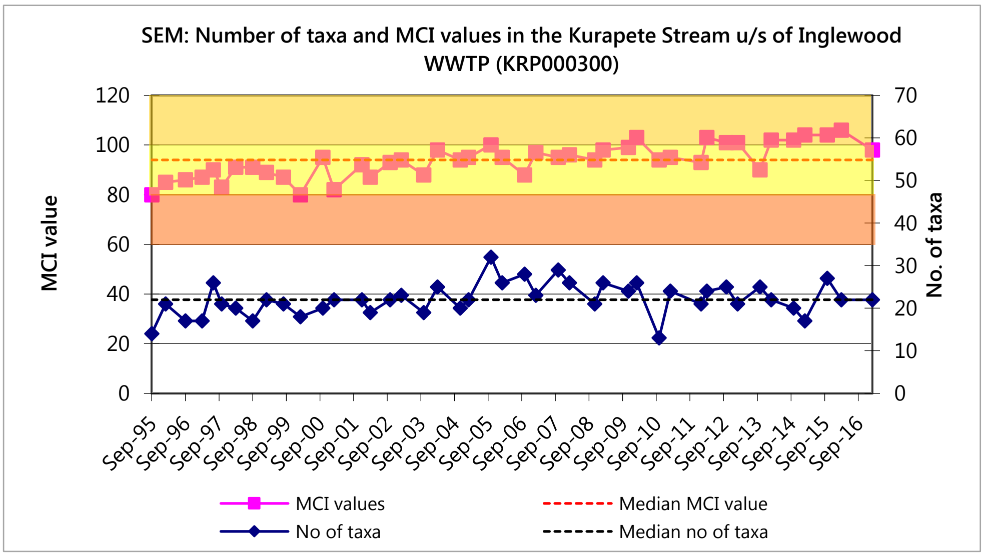


Figure 50 Numbers of taxa and MCI values in the Kurapete Stream upstream of the Inglewood WWTP

A relatively wide range of richnesses (13 to 32 taxa) has been found with a moderate median richness of 22 taxa, relatively typical of richnesses in the mid reaches of ringplain streams rising outside the National Park boundary. During the 2016-2017 period summer (22 taxa) richness was identical to the historical median richness coincident with the thin (summer) periphyton layers on the predominantly cobble/boulder substrate of this shaded site.

MCI values have had a moderate range (26 units) at this site, typical of mid-reach sites in seepage streams on the ringplain. The summer 2017 (98 units) score was not significantly different to the historical median. The scores categorised this ringplain seepage stream site as having 'fair' health generically (Table 2). The historical median score (94 units) placed this site in the 'fair' category for generic health.

3.2.7.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 39.

Table 39 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kurapete Stream upstream of Inglewood WWTP, between 1996 and March 2016 [43 surveys], and by the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	1			1	2	
NEMERTEA	Nemertea	3	1			1	2	
ANNELIDA (WORMS)	Oligochaeta	1	26	8		34	81	VA
MOLLUSCA	*Potamopyrgus*	4	16	10	2	28	67	A
CRUSTACEA	Paraleptamphopidae	5	3			3	7	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	8	7		15	36	
	Coloburiscus	7	2	1		3	7	A
	Deleatidium	8	3	2		5	12	
	Zephlebia group	7	5	12	5	22	52	VA
PLECOPTERA (STONEFLIES)	*Acroperla*	5	2			2	5	
COLEOPTERA (BEETLES)	Elmidae	6	10	14		24	57	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	17			17	40	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	26	3		29	69	A
	Hydrobiosis	5	3			3	7	
	Oxyethira	2	1			1	2	
	Pycnocentria	7	18	4		22	52	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	3			3	7	
	Maoridiamesa	3	17	9		26	62	
	Orthocladiinae	2	1			1	2	
	Polypedilum	3	14	8	3	25	60	
	Tanypodinae	5	1			1	2	
	Austrosimulium	3	1			1	2	

Prior to the current 2016-2017 period 20 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', nine 'moderately sensitive', and ten 'tolerant' taxa i.e. a relatively even balance between 'sensitive' and 'tolerant' taxa as might be expected in the mid-reaches of a ringplain stream rising outside the National Park. Predominant taxa have included two 'moderately sensitive' taxa [elmid beetles and cranefly (*Aphrophila*)] and five 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), orthoclad midges, and sandfly (*Austrosimulium*)].

The summer 2017 community consisted of six historically characteristic which were a mixture of sensitive and tolerant taxa which was reflected in the $SQMCI_s$ score of 4.4 units reflecting fair macroinvertebrate health (Table 39 and Table 138).

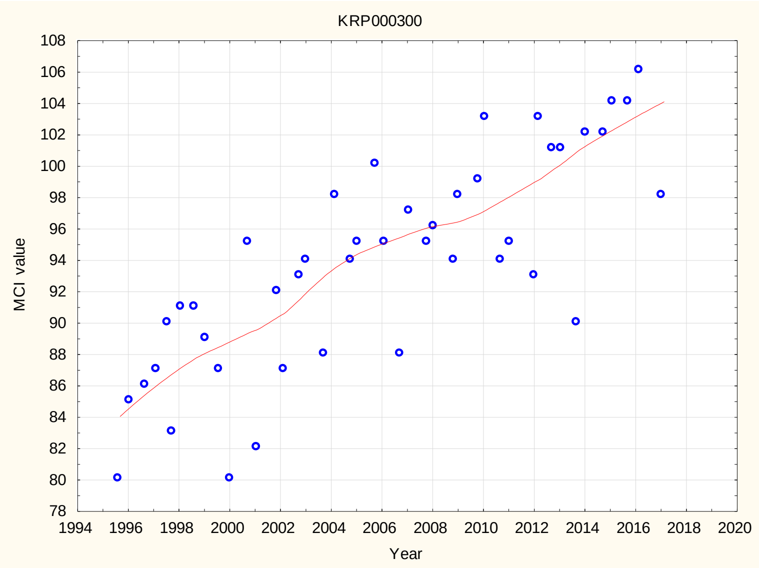
3.2.7.1.3 Predicted stream 'health'

The Kurapete Stream rises below the National Park boundary and the site upstream of the Inglewood WWTP is in the mid-reaches at an altitude of 180 m asl.

The median value for a ringplain stream arising outside the National Park at a similar altitude (TRC, 2016b) was 89 units. The historical median was significantly below the median value but the summer score was not significantly different. The REC predicted MCI value (Leathwick, et al. 2009) was also 92 units. Again, the historical median and summer scores were both not significantly different to this median value he summer score was not significantly different to the REC value (Stark, 1998).

3.2.7.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 51). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Kurapete Stream upstream of the Inglewood WWTP.



N = 44
Kendall tau = +0.640
p level < 0.001
FDR p = < 0.001

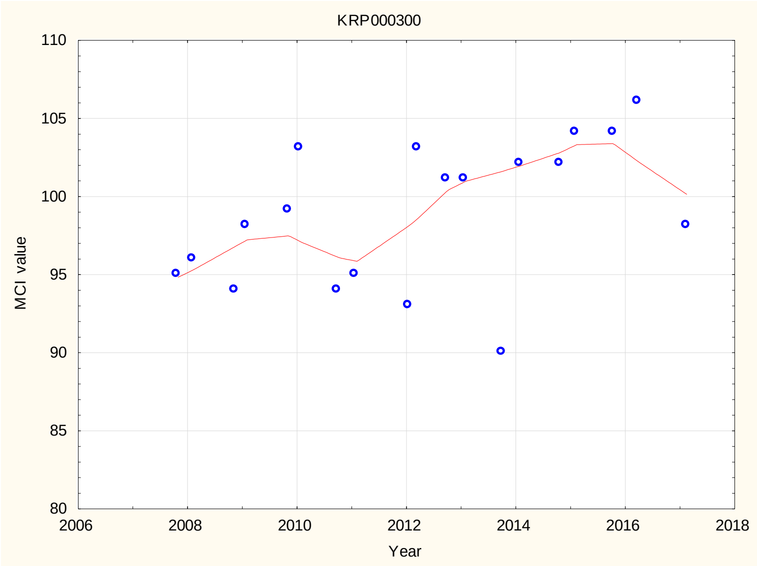
Figure 51 LOWESS trend plot of MCI data in the Kurapete Stream at the site upstream of the Inglewood WWTP

The very strong positive temporal trend in MCI scores has been highly significant at this site (FDR $p < 0.01$) immediately upstream of the Inglewood WWTP discharge but below the tributary inflow draining the old Inglewood landfill. This improvement has followed the diversion of the iron-oxide laden drainage out of the stream and into the WWTP system which markedly reduced sediment deposition on the streambed. The strong earlier trend tended to ease between 2004 and 2009 with a subsequent increase in improvement more recently. The overall range of MCI scores across the trendline (20 units) has been ecologically important.

The trendline range of MCI scores have been indicative of 'fair' generic stream health (Table 2) throughout the period until recently where it is now of 'good' health.

3.2.7.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 52). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Kurapete Stream upstream of the Inglewood WWTP.



N = 19
Kendall tau = +0.394
p level = 0.018
FDR p = 0.277

Figure 52 LOWESS trend plot of ten years of MCI data in the Kurapete Stream at the site upstream of the Inglewood WWTP

A positive but non-significant trend in MCI scores has been found over the ten year period. The trendline was indicative of 'fair' health (Table 2) for the earlier part of the ten year period before reaching 'good' health from 2013 to 2016 before a subsequent decrease from during 2017.

3.2.7.2 Site approximately 6km downstream of the Inglewood WWTP outfall (KRP000660)

3.2.7.2.1 Taxa richness and MCI

Forty-three surveys have been undertaken at this lower reach site in the Kurapete Stream 6 km downstream of the Inglewood WWTP outfall (KRP000660) between 1995 and March 2016. These results are summarised in Table 40, together with the results from the current period, and illustrated in Figure 53.

Table 40 Results of previous surveys performed in the Kurapete Stream at the site 6km downstream of the Inglewood WWTP outfall together with the summer 2017 result

Site code	SEM data (1995 to March 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
KRP000660	43	14-30	25	70-112	93	21	96

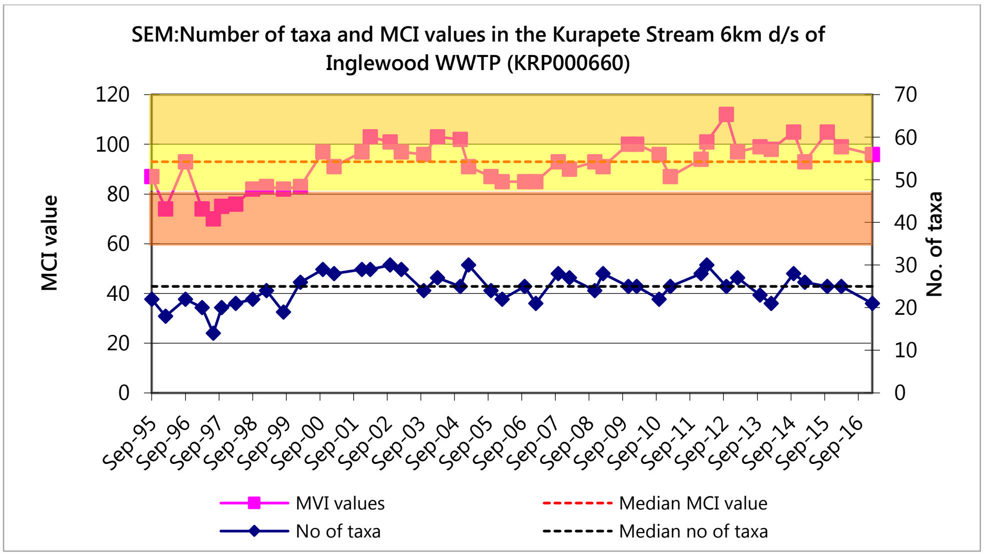


Figure 53 Numbers of taxa and MCI values in the Kurapete Stream, 6 km downstream of the Inglewood WWTP outfall

A moderate range of richnesses (14 to 30 taxa) has been found, with a median richness of 25 taxa (slightly higher than typical of richnesses for the lower mid-reaches of ringplain streams rising outside the National Park boundary. During the 2016-2017 period summer (21 taxa) richness were slightly lower than the historical median.

MCI values have had a wide range (42 units) at this site. The median value (93 units) has been typical of lower mid-reach sites in similar seepage-fed streams elsewhere on the ringplain (TRC, 2016b). The summer 2017 (96 units) score was not significantly different to the historic median (Stark, 1998). These scores categorised this site as having 'fair' (summer) health generically (Table 2). The historical median score (93 units) placed this site in the 'fair' category for generic health.

3.2.7.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 41.

Table 41 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kurapete Stream at the site 6 km downstream of Inglewood WWTP outfall, between 1996 and March 2016 [43 surveys], and the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	1			1	2	
NEMERTEA	Nemertea	3	3			3	7	
NEMATODA	Nematoda	3	1			1	2	
ANNELIDA (WORMS)	Oligochaeta	1	18	14	3	35	85	
MOLLUSCA	*Potamopyrgus*	4	14	9	2	25	61	
CRUSTACEA	Ostracoda	1	1			1	2	

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	8	2		10	24	A
	Coloburiscus	7	7	4		11	27	
	Deleatidium	8	3	7		10	24	
	Zephlebia group	7	7	5		12	29	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	8	2		10	24	
COLEOPTERA (BEETLES)	Elmidae	6	16	11		27	66	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	17			17	41	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	8	18	1	27	66	A
	Costachorema	7	2			2	5	
	Hydrobiosis	5	18	1		19	46	
	Oxyethira	2	8	5		13	32	
	Pycnocentria	7	5	4		9	22	
	Pycnocentrodes	5	20	8		28	68	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	11	1		12	29	A
	Maoridiamesa	3	24	12	4	40	98	
	Orthocladiinae	2	4			4	10	A
	Tanytarsini	3	2			2	5	
	Empididae	3	3			3	7	
	Muscidae	3	16	1	1	18	44	
	Austrosimulium	3	1			1	2	

Prior to the current 2016-2017 period, 25 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', eleven 'moderately sensitive', and fourteen 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa, which is typical of the lower mid-reaches of a ringplain stream. Taxa that have been characteristic taxa for over 50% of the time have included two 'moderately sensitive' taxa [elmid beetles and cranefly (*Aphrophila*)] and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges]. The summer 2017 community consisted of six characteristic taxa comprising more 'sensitive' than 'tolerant' taxa as reflected in the SQMCI$_s$ score of 6.1 indicating 'very good' macroinvertebrate health (Table 41) (Table 138).

3.2.7.2.3 Predicted stream 'health'

The Kurapete Stream rises below the National Park boundary and the site 6 km downstream of the Inglewood WWTP outfall is in the lower mid-reaches at an altitude of 120 m asl.

The median value for a ringplain stream arising outside the National Park (TRC, 2016b) at similar altitude was 102 units. The historical median and summer scores were not significantly different to this value. The

REC predicted MCI value (Leathwick, et al. 2009) was also 102 units and therefore the historical median and summer scores were not significantly different from this value (Stark, 1998).

3.2.7.2.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 54). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Kurapete Stream at the site six km downstream of the Inglewood WWTP outfall.

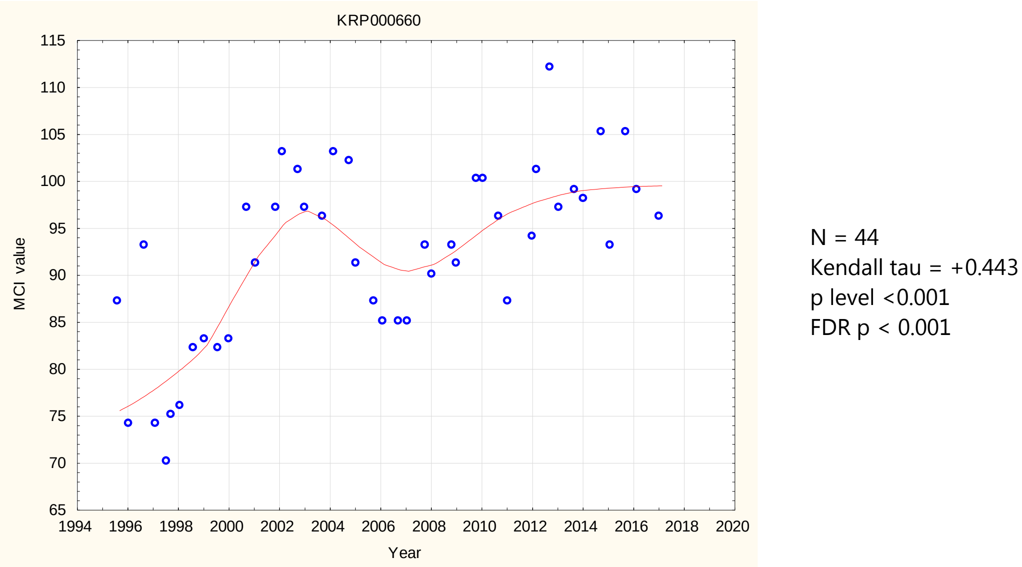


Figure 54 LOWESS trend plot of MCI data in the Kurapete Stream for the site 6 km downstream of the Inglewood WWTP outfall

There has been a highly significant positive trend of MCI score improvement (FDR p<0.01). There was a noticeably increase in the steepness of the trend after 2000 (following diversion of all Inglewood WWTP wastes out of the stream (to the New Plymouth WWTP) which was emphasised by an ecologically important increase in average score of 17 units over a five year period. Subsequently, a decreasing trend in scores has been followed by a steady recovery since 2007 coincident with relatively few consented municipal wastes short-duration discharge overflows to the stream during recent years.

Overall, the trendline scores indicated improving stream health from 'poor' to 'fair' (Table 2) indicative of the positive effects of diversion of the Inglewood WWTP discharge out of the stream.

3.2.7.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 55). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Kurapete Stream at the site six km downstream of the Inglewood WWTP outfall.

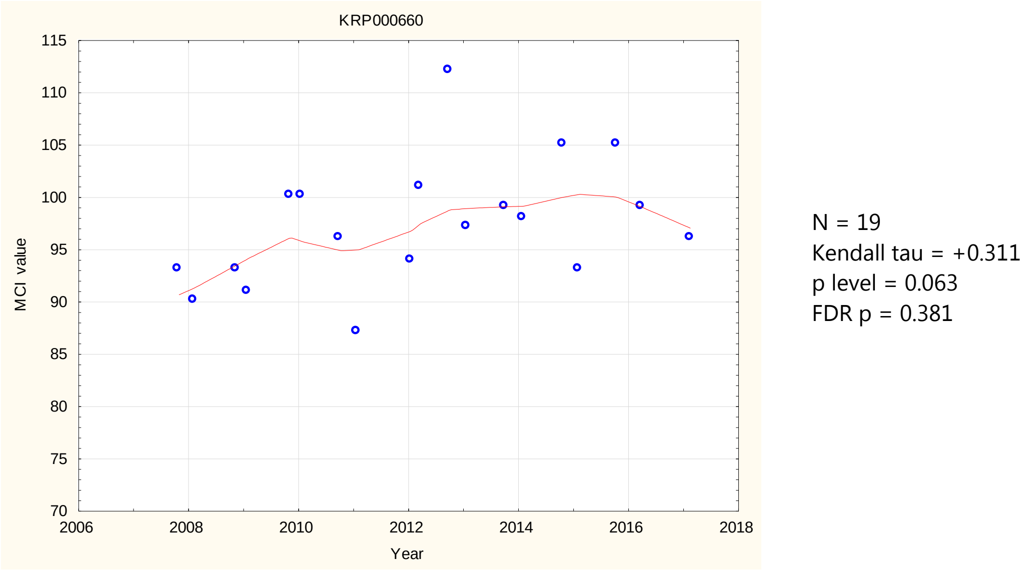


Figure 55 LOWESS trend plot of ten years of MCI data in the Kurapete Stream for the site 6 km downstream of the Inglewood WWTP outfall

A positive non-significant trend in MCI scores has been found over the ten year period with a slight overall increase in the trendline over the ten year period. The trendline was indicative of 'fair' health (Table 2).

3.2.7.3 Discussion

The two Kurapete Stream sites both had moderate taxa richnesses which were similar to historic medians.

MCI and SQMCIs scores generally indicated that both sites had 'fair' macrinvertebrate health though the lower site had a high SQMCIs score more consistent with a 'very good' macroinvertebrate community health due to large numbers of sensitive mayflies. MCI scores were typical for the two sites with little difference from historic medians. MCI scores fell in a downstream direction between the upper site and the furtherest downstream lower reaches site but only by a non-significant two units. This is a typical result with only a one unit difference between historic medians between the two sites.

The time trend analysis showed the sites had significant positive trends over the full and ten year datasets indicating that macroinvertebrate communities have been getting healthier over time.

3.2.8 Maketawa Stream

The Maketawa Stream is a ringplain stream with a source inside Egmont National Park that flows in an easterly direction into the Manganui River. Two sites, originally surveyed as components of the Maketawa catchment baseline investigation (Stark, 2003), were included in the 2002-03 SEM programme in recognition of the fisheries significance of this sub-catchment of the Manganui River catchment. The results from the surveys performed in the 2016-2017 monitoring year are presented in Table 139, Appendix I. Due to persistently high flows no spring 2016 survey was able to be completed.

3.2.8.1 Derby Road site (MKW000200)

3.2.8.1.1 Taxa richness and MCI

Thirty-three surveys have been undertaken at this upper reach site in the Maketawa Stream between March 1998 and February 2016. These results are summarised in Table 42 together with the results from the current period, and illustrated in Figure 56.

Table 42 Results of previous surveys performed in the Maketawa Stream at Derby Road together with summer 2017 results

Site code	SEM data (1995 to March 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
MKW000200	33	8-33	23	100-141	128	13	142

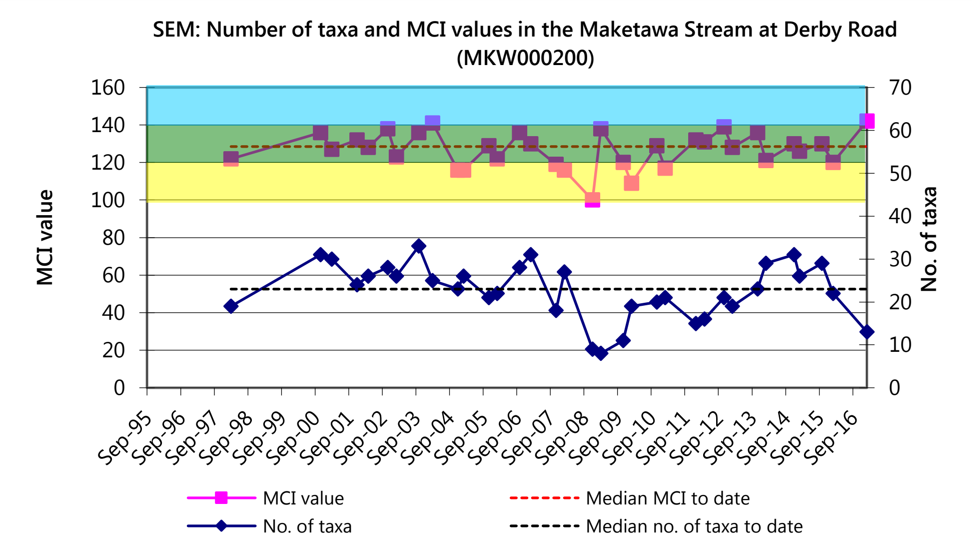


Figure 56 Number of taxa and MCI values in the Maketawa Stream at Derby Road

A very wide range of richnesses (8 to 33 taxa) has been found as a result of marked reductions in richness due to the impacts of previous headwater erosion events, with a median richness of 23 taxa (slightly lower than typical richnesses found in the upper reaches of ringplain streams and rivers). During the 2016-2017 period, summer (13 taxa) richnesses were towards the lower end of the range previously recorded (Figure 56).

MCI values have had a very wide range (41 units) at this site, atypical of a site in the upper reaches of a ringplain stream mainly due to headwater erosion effects referenced above. The median value (128 units) however, has been more typical of upper reach sites elsewhere on the ringplain. The summer 2017 (142 units) score was the highest score ever recorded at the site and significantly higher (Stark, 1998) than the historic median. The score categorised this site as having 'excellent' generic health (Table 2) in summer, the highest possible health category. The historical median score (128 units) placed this site in the 'very good' category for generic health.

3.2.8.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 43.

Table 43 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Maketawa Stream at Derby Road between 1995 and February 2016 [33 surveys], and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	1			1	3	
	Coloburiscus	7	8	7		15	45	
	Deleatidium	8	3	5	25	33	100	XA
	Nesameletus	9	10	13		23	70	A
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	14			14	42	
	Zelandoperla	8	18	9		27	82	A
COLEOPTERA (BEETLES)	Elmidae	6	6	19	5	30	91	VA
	Hydraenidae	8	3			3	9	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	10	2		12	36	
	Costachorema	7	5			5	15	A
	Hydrobiosis	5	1			1	3	
	Beraeoptera	8	6	5	3	14	42	
	Helicopsyche	10	3	4	2	9	27	
	Olinga	9	1			1	3	
	Pycnocentrodes	5	7	3		10	30	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	16	2		18	55	
	Eriopterini	5	4			4	12	
	Maoridiamesa	3	7	2		9	27	
	Orthocladiinae	2	8			8	24	

Prior to the current 2016-2017 period, 19 taxa have characterised the community at this site on occasions. These have comprised eight 'highly sensitive', eight 'moderately sensitive', and three 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the upper reaches of a ringplain stream. Predominant taxa have included three 'highly sensitive' taxa [mayflies (*Deleatidium* on every occasion, and *Nesameletus*) and stonefly (*Zelandoperla*)] and two 'moderately sensitive' taxa [elmid beetles and cranefly (*Aphrophila*)]. The summer 2017 community was characterised by five characteristic taxa that were all sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.7 units (Table 43) (Table 139).

3.2.8.1.3 Predicted stream 'health'

The Maketawa Stream site at Derby Road is 2.3 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 121 for this site. The historical site median (128 units) was not significantly higher than the distance predictive value but the summer score (142 units) was significantly higher than the distance predictive value.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 129 units. The historical site median and summer scores were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 130 units. The historical site median and summer scores were also not significantly different to this value.

3.2.8.1.4 Temporal trends in 1998 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 57). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 19 years of SEM results (1998-2017) from the site in the Maketawa Stream at Derby Road.

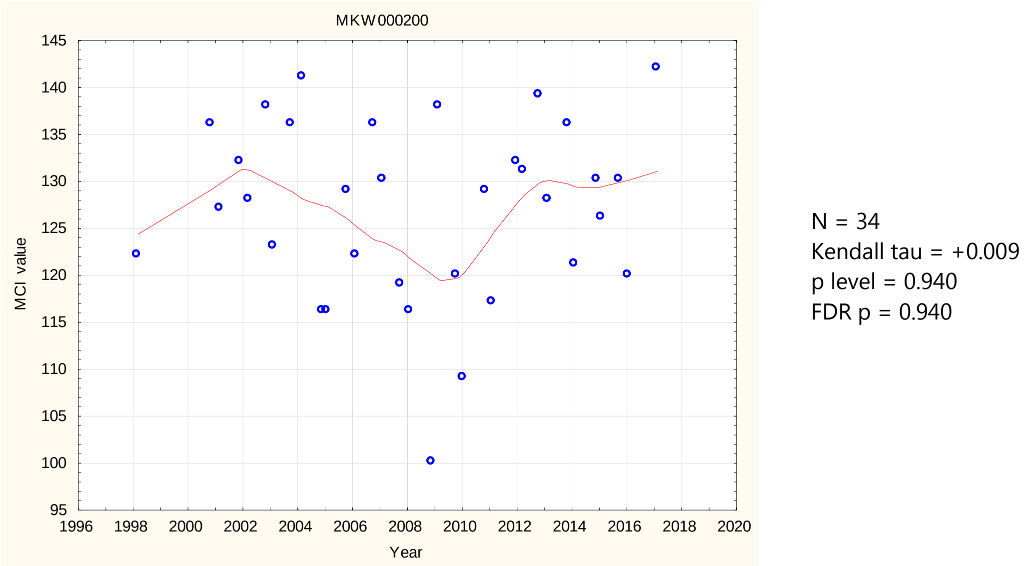


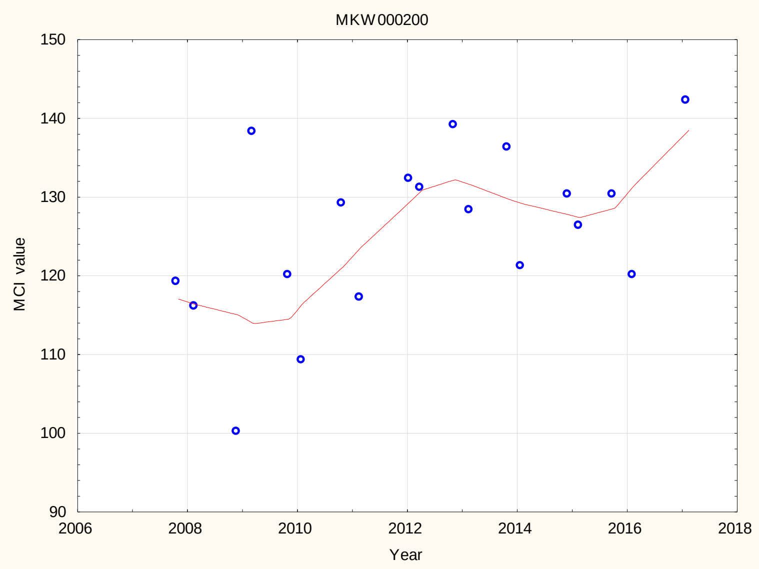
Figure 57 LOWESS trend plot of MCI data at the Derby Road site, Maketawa Stream

No significant temporal trend in the overall very slight increase in MCI scores has been found over the 19-year monitoring period at this relatively pristine site. Scores decreased following the headwater erosion events, prior to recovery over the more recent five-year period. The variability in the trendline (range 12 units) represented some ecological importance during the period accentuated by the impact of headwater erosion events during 2008.

Overall, the trendline remained indicative of 'very good' generic stream health (Table 2) for the majority of the period, dropping toward 'good' health briefly between 2008 and 2010.

3.2.8.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 58). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Maketawa Stream at Derby Road.



N = 19
Kendall tau = +0.300
p level = 0.073
FDR p = 0.381

Figure 58 LOWESS trend plot of ten years of MCI data at the Derby Road site, Maketawa Stream

No significant trend in the MCI scores has been found over the ten year monitoring period. There was a slight positive trend congruent with the full dataset. Overall, the trendline remained indicative of 'very good' generic stream health (Table 2) for the majority of the period, dropping toward 'good' health briefly between 2008 and 2010 due to the headwater erosion event.

3.2.8.2 Tarata Road site (MKW000300)

3.2.8.2.1 Taxa richness and MCI

Thirty-two surveys have been undertaken at this mid-reach site at Tarata Road in the Maketawa Stream between March 1998 and February 2016. These results are summarised in Table 44, together with the results from the current period, and illustrated in Figure 59.

Table 44 Results of previous surveys performed in the Maketawa Stream at Tarata Road together with summer 2017 results

Site code	SEM data (1995 to March 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
MKW000300	32	12-31	22	90-119	107	20	112

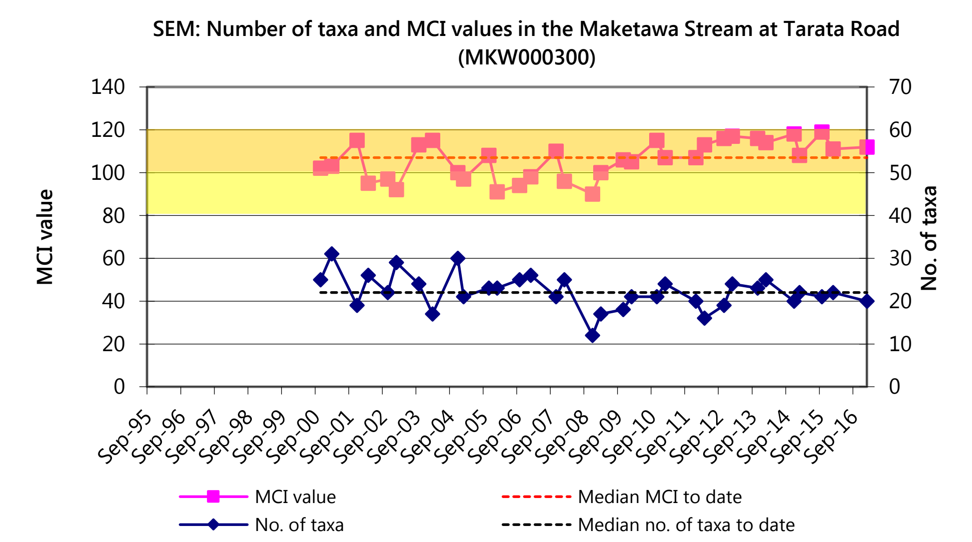


Figure 59 Number of taxa and MCI values in the Maketawa Stream at Tarata Road

A wide range of richnesses (12 to 31 taxa) has been found; wider than might be expected, with a median richness of 22 taxa which is more representative of typical richnesses in the mid-reaches of ringplain streams and rivers. During the 2016-2017 period, summer (20 taxa) richness was similar to the median taxa number. MCI scores have had a relatively wide range (29 units) at this site, more typical of sites in the mid to lower reaches of ringplain streams. The median value (107 units) has been relatively typical of mid-reach sites elsewhere on the ringplain (TRC, 2016b). The summer 2017 (112 units) score was within the range typical for the site and not significantly different to the historical median (Stark, 1998). The summer score categorized this site as having 'good' health generically (Table 2). The historical median score (107 units) also placed this site in the 'good' category for generic health.

3.2.8.2.2 Community composition

Characteristic macroinvertebrate taxa abundant in the communities at this site prior to the 2016-2017 period are listed in Table 45.

Table 45 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Maketawa Stream at Tarata Road between 1995 and February 2016 [32 surveys], and the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer
ANNELIDA (WORMS)	Oligochaeta	1	2	3	2	7	22	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	3			3	9	
	Coloburiscus	7	13	4	1	18	56	
	Deleatidium	8	4	8	11	23	72	XA
	Nesameletus	9	1			1	3	
PLECOPTERA (STONEFLIES)	*Acroperla*	5		1		1	3	
COLEOPTERA (BEETLES)	Elmidae	6	9	3		12	38	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	3			3	9	

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	11	8	1	20	63	A
	Costachorema	7	12	2		14	44	
	Hydrobiosis	5	8			8	25	
	Neurochorema	6	3			3	9	
	Beraeoptera	8	4			4	13	
	Confluens	5	2			2	6	
	Oxyethira	2	1	3		4	13	
	Pycnocentrodes	5	1	2		3	9	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	19	7		26	81	A
	Maoridiamesa	3	13	9	2	24	75	
	Orthocladiinae	2	17	9	3	29	91	
	Tanytarsini	3	5	3	1	9	28	
	Empididae	3	1			1	3	
	Muscidae	3	4			4	13	
	Austrosimulium	3	1	1		2	6	

Prior to the current 2016-2017 period 23 taxa have characterised the community at this site on occasions. These have comprised three 'highly sensitive', eleven 'moderately sensitive', and nine 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as might be expected in the mid-reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa, [mayfly (*Coloburiscus*) and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche- Aoteapsyche*) and midges (orthoclads and *Maoridiamesa*)]. The summer community had four characteristic taxa that were mostly sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.5 units indicating excellent macroinvertebrate health (Table 45) (Table 139).

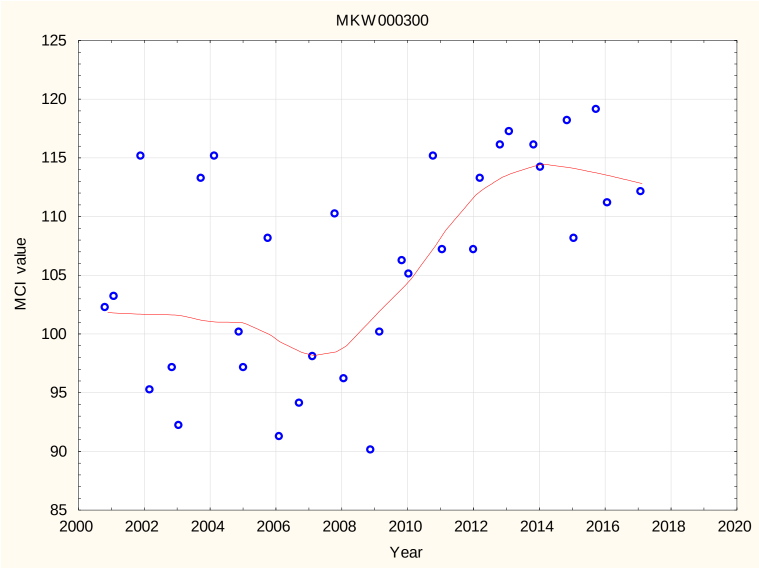
3.2.8.2.3 Predicted stream 'health'

The Maketawa Stream site at Tarata Road is 15.5 km downstream of the National Park boundary at an altitude of 150 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 101 for this site. The historical site median (107 units) is six units above the predictive distance value. The summer score (112 units) was significantly higher than the distance predictive score by 11 units.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 102 units. The historical site median and summer scores were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 111 units. The historical site median and summer scores were also not significantly different to this value.

3.2.8.2.4 Temporal trends in 2000 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 60). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 17 years of SEM results (2000-2017) from the site in the Maketawa Stream at Tarata Road.



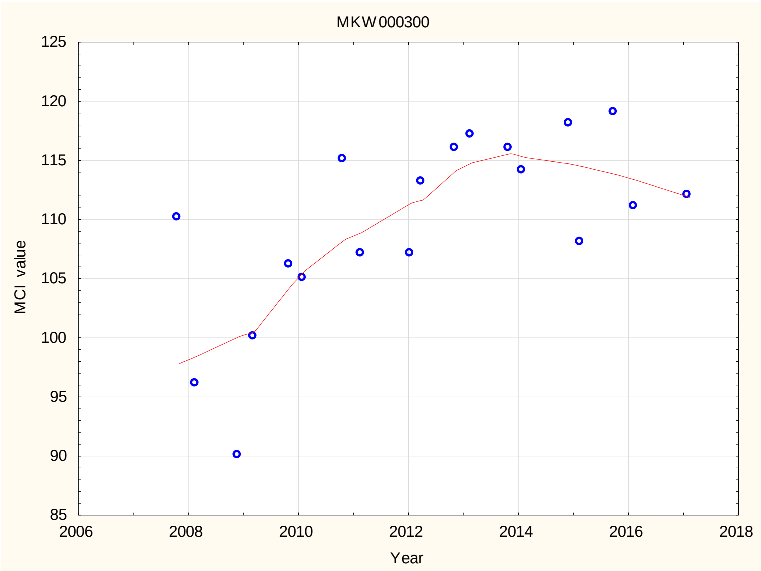
N = 33
Kendall tau = +0.392
p level = 0.001
FDR p = 0.004

Figure 60 LOWESS trend plot of MCI data at the Tarata Road site

The positive trend in MCI scores found over the 17-year monitoring period has been statistically significant (FDR p <0.01). Ecological variability, which have ranged over 17 units, has been important ecologically with scores indicative of 'good' generic stream health (Table 2) trending downward to 'fair' stream health, between 2005 and 2009 before returning to 'good' health where it currently remains.

3.2.8.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 61). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on ten years of SEM results (2007-2017) from the site in the Maketawa Stream at Tarata Road.



N = 19
Kendall tau = +0.512
p level = 0.002
FDR p = 0.123

Figure 61 LOWESS trend plot of ten years of MCI data at the Tarata Road site, Maketawa Stream

The positive trend in MCI scores found over the ten year monitoring period has not been statistically significant. The trendline was indicative of 'good' generic stream health (Table 2) trending downward to 'fair' stream health, between 2005 and 2009 before returning to 'good' health where it currently remains.

3.2.8.3 Discussion

The upper Maketawa Stream site had lower than normal taxa richness which was probably caused by a significant number of freshes preceding the survey. The lower site had a typical, moderate, taxa richness and therefore had largely been unaffected by the freshes with a taxa richness that was only two taxa less than the historical median.

MCI and $SQMCI_s$ scores at the upper Maketawa Stream site indicated that the macroinvertebrate community was in 'excellent' health and the MCI score was the highest recorded to date. The lower Maketawa Stream site MCI score indicated 'good' macroinvertebrate health but the $SQMCI_s$ score suggested 'excellent' health as a result of large numbers of sensitive mayflies. Generally, there was a decrease in highly sensitive species at the lower site and in this case the MCI score was probably a better indicator of overall macroinvertebrate health. MCI scores fell in a downstream direction between the upper site and the downstream site by a significant 30 units. This was larger than the usual 21 unit difference between historical medians.

The time trend analysis showed the upper site had no significant trends which would be expected from a site with few impacts that has not changed significantly over time. The lower site had a significant positive trends over the full and ten year datasets indicating that macroinvertebrate communities have been getting healthier over time. Long term improvements in macroinvertebrate health at the site were likely in relation to higher levels of fencing and riparian planting in the catchment in combination with a reduction in point source inputs from farm oxidation ponds with effluent now being discharged to land.

3.2.9 Mangaehu River

The Mangaehu River is a large eastern hill country river and is a major tributary of the Patea River. There is one SEM site located on the Mangaehu River in its lower reaches. The results found by the 2016-2017 surveys are presented in Table 140, Appendix I.

3.2.9.1 Raupuha Road site (MGH000950)

3.2.9.1.1 Taxa richness and MCI

Forty-two surveys have been undertaken at this lower reach site in the Mangaehu River between October 1995 and February 2016. These results are summarised in Table 46, together with the results from the current period, and illustrated in Figure 62.

Table 46 Results of previous surveys performed in the Mangaehu River at Raupuha Road, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGH000950	42	13-26	20	77-104	92	12	92	21	92

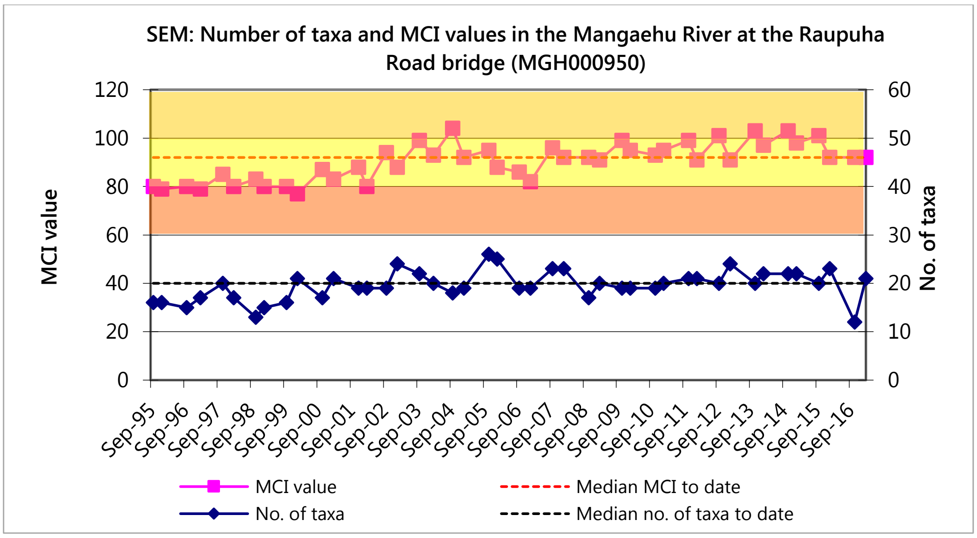


Figure 62 Numbers of taxa and MCI values in the Mangaehu River at Raupuha Road

A relatively wide range of richnesses (13 to 26 taxa) has been found with a moderate median richness of 20 taxa (slightly above typical richnesses in the lower reaches of hill country rivers, although generally at lower altitudes (TRC, 2016b)). During the 2016-2017 period, spring (12 taxa) taxa richness was the lowest ever recorded at the site to date and eight taxa less than the historical median. In contrast, summer (21 taxa) richness was very similar to the historical median.

MCI values have had a relatively wide range (27 units) at this site more typical of a site in the lower reaches of streams and rivers. The median value (92 units) has been typical of lower reach sites. The spring 2016 (92 units) and summer 2017 (92 units) scores were identical to the historic median. These scores categorised this site as having 'fair' health generically (Table 2) in spring and summer respectively. The historical median score (92 units) placed this site in the 'fair' category for the generic method of assessment.

3.2.9.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 47.

Table 47 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Mangaehu River at Raupuha Road between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List	Date	MCI	A	VA	XA	Total	%	Survey	
	Sample Number							Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	1			1	2		
ANNELIDA (WORMS)	Oligochaeta	1	2	2		4	10		
MOLLUSCA	*Potamopyrgus*	4	10	1		11	26		A
CRUSTACEA	*Paracalliope*	5	4	1		5	12		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	10	3		13	31		
	Coloburiscus	7	3			3	7		
	Deleatidium	8	5	1		6	14		
	Mauiulus	5	1			1	2		

Taxa List	Date	MCI	A	VA	XA	Total	%	Survey	
	Sample Number							Spring 2016	Summer 2017
	Zephlebia group	7	5			5	12		
PLECOPTERA (STONEFLIES)	*Acroperla*	5	8	1		9	21		
COLEOPTERA (BEETLES)	Elmidae	6	4			4	10		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	14	10		24	57		A
	Costachorema	7	8			8	19		
	Hydrobiosis	5	14	5		19	45		
	Oxyethira	2	2			2	5		
	Pycnocentrodes	5	11	8		19	45		VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	13	20		33	79	A	VA
	Maoridiamesa	3	16	12		28	67		A
	Orthocladiinae	2	20	16	3	39	93	VA	A
	Tanytarsini	3	14	5		19	45		A
	Empididae	3	4			4	10		
	Muscidae	3	7			7	17		
	Austrosimulium	3	5	1		6	14		

Prior to the current 2016-2017 period, 23 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', eleven 'moderately sensitive', and 11 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower reaches of an eastern hill-country river. Predominant taxa have included only one 'moderately sensitive' taxon [cranefly (*Aphrophila*)] and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)]. There were only two characteristic taxa in the spring 2016 survey with a tolerant taxa the most abundant causing a low $SQMCI_s$ score of 2.8 units indicating 'poor' health. The summer 2017 community was characterised by seven taxa that were a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 4.5 units indicating fair health (Table 47) (Table 140).

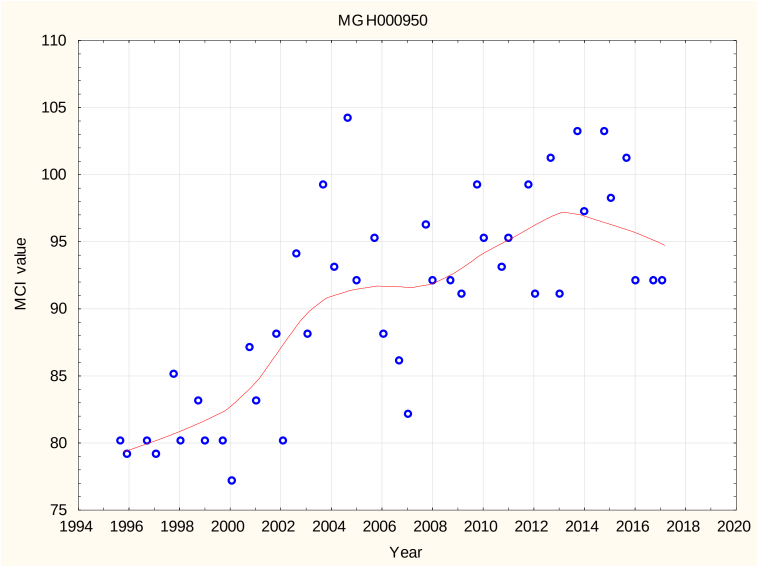
3.2.9.1.3 Predicted stream 'health'

The Mangaehu River site at Raupuha Road, at an altitude of 100 m asl, is in the lower reaches of a river draining an eastern hill country catchment.

The median value for large eastern hill country rivers of similar altitude (TRC, 2016b) was 93 units. The historical median, spring and summer and scores were all not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 117 units. . The historical median, spring and summer and scores were all significantly lower than this value.

3.2.9.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 63). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Mangaehu River at Raupuha Road.



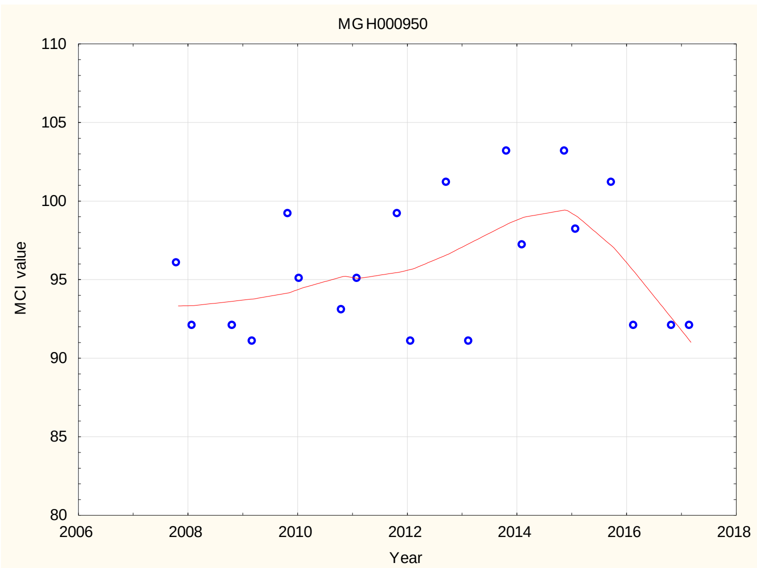
N = 44
Kendall tau = +0.535
p value < 0.001
FDR p < 0.001

Figure 63 LOWESS trend plot of MCI data for the Raupuha Road site, Mangaehu River

A significant positive temporal trend in MCI scores (p<0.01 after FDR) was found at this lower reach, hill country river site. The wide range of trendline scores (19 units) has also been ecologically important, particularly over the period since 2000. Smoothed MCI scores originally bordering on 'poor/fair' generic river health (Table 2) have trended upward to 'fair' approaching 'good' health very recently (Figure 63).

3.2.9.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 64). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Mangaehu River at Raupuha Road.



N = 20
Kendall tau = +0.116
p value = 0.475
FDR p = 0.682

Figure 64 LOWESS trend plot of ten years of MCI data for the Raupuha Road site, Mangaehu River

A non-significant positive trend in MCI scores after FDR adjustment was found at this lower reach, hill country river site in contrast to the highly significant positive trend found in the full dataset. The trendline showed an increase until 2015 before decreasing from 2015 onwards. The trendline was in the 'fair' generic river health (Table 2) range (Figure 64).

3.2.9.2 Discussion

The Mangaehu River had the lowest recorded taxa richness to date for the spring survey and typical, moderate, taxa richness during summer. Animal abundance were also low during the spring survey. A moderate fresh (> 3x median flow) had occurred eight days prior to the spring sampling but there was over a hundred days since a large fresh (> 7x median flow), suggesting elevated flows were not the cause of the decrease.

MCI and $SQMCI_s$ scores at the site indicated that the macroinvertebrate community was generally in 'fair' health. The $SQMCI_s$ score during spring indicated poorer health but this was affected by poor taxa richnesses and abundances.

The time trend analysis showed a significant positive trend over the full dataset indicating that macroinvertebrate communities have been getting healthier over time. There was no significant trend for the ten year dataset. Long term improvements in macroinvertebrate health at the site were likely in relation to an apparent reduction in river bed sedimentation possibly related to fewer severe flood events particularly since 2000 with scores tending to plateau between in 2004 and 2008 before improving steadily again since then. Work has also been undertaken encouraging farmers to stabilise erosion prone hill slopes by planting appropriate vegetation such as poplar. Recent scores show a decrease in the trend coincident with widespread periphyton mats on the streambed in conjunction at times with widespread filamentous periphyton which provide favourable habitat and food for more tolerant taxa resulting in lower macroinvertebrate health scores.

3.2.10 Manganui River

The Manganui River is a ringplain river whose source is inside Egmont National Park and is a significant tributary of the Waitara River. There are two SEM sites located on the river, one at its mid reaches and another at its lower reaches. The results found by the 2016-2017 surveys are presented Table 140 Table 141 and Table 142.

3.2.10.1 State Highway 3 site (MGN000195)

3.2.10.1.1 Taxa richness and MCI

Forty-four surveys have been undertaken at this mid reach site in the Manganui River between September 1995 and February 2016. These results are summarised in Table 48 together with the results from the current period, and illustrated in Figure 65.

Table 48 Results of previous surveys performed in the Manganui River u/s of railway bridge (SH 3), together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGN000195	44	12-26	21	113-143	126	9	124	14	106

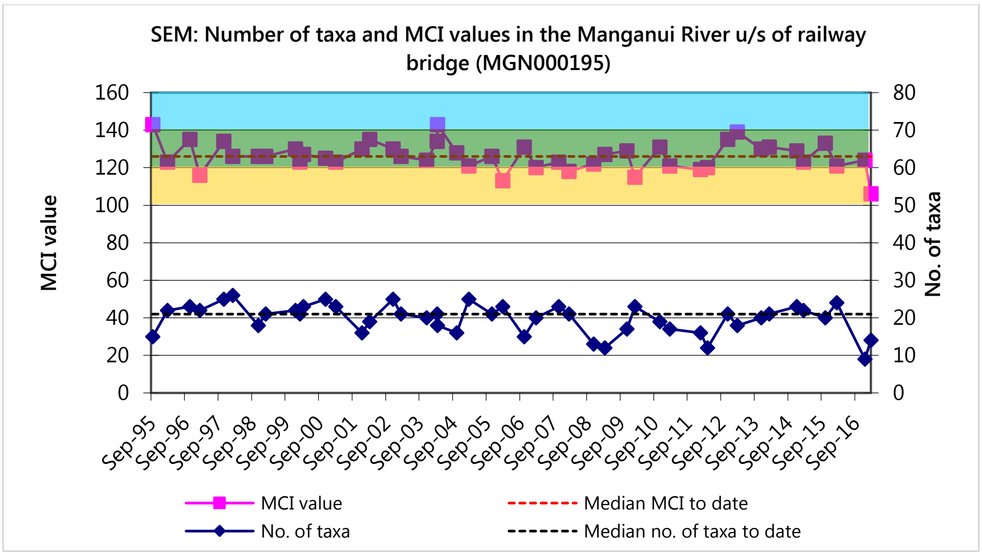


Figure 65 Numbers of taxa and MCI values in the Manganui River above the railway bridge (SH3)

A wide range of richnesses (12 to 26 taxa) has been found, with a median richness of 21 taxa which was slightly lower than typical richnesses in the mid-reaches of ringplain streams and rivers, (TRC, 2016b). During the 2016-2017 period richnesses were relatively low for the site with the spring (9 taxa) richness the lowest taxa richness recorded at the site to date and the summer (14 taxa) richness also significantly below the historic median.

MCI values have had a relatively wide range (30 units) at this site, slightly wider than typical for a site in the mid reaches of a ringplain stream. The median value (126 units) was higher than has been typical of similar mid-reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (124 units) score was not significantly different to the historical median but the summer 2017 (106 units) score was significantly lower (Stark, 1998) than the historical median by 20 units and the lowest recorded score to date. The low spring taxa richness combained with the low summer MCI score were highly suggestive that either water and/or habitat quality had been impacted for the year under review. These scores categorised this site as having 'very good' health generically (Table 2) in spring and 'good' health in summer. The historical median score (126 units) placed this site in the 'very good' generic health.

3.2.10.1.2 Community composition

Characteristic macroinvertebrate taxa (abundant) in the communities at this site prior to the 2016-2017 period are listed in Table 49.

Table 49 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Manganui River at SH3 between 1995 and February 2016 [44 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	4			4	9		
	Coloburiscus	7	19	13		32	73		
	Deleatidium	8	6	18	19	43	98	VA	VA
	Nesameletus	9	21	10		31	70		
PLECOPTERA (STONEFLIES)	*Acroperla*	5	2			2	5		

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
	Megaleptoperla	9	1			1	2		
	Zelandoperla	8	12	3		15	34		
COLEOPTERA (BEETLES)	Elmidae	6	21	19	1	41	93	A	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	4			4	9		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	16	2		18	41		
	Hydrobiosis	5	1			1	2		
	Beraeoptera	8	9	4		13	30		
	Olinga	9	1			1	2		
	Pycnocentrodes	5	4	1		5	11		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	23	2		25	57		
	Eriopterini	5	3			3	7		
	Austrosimulium	3	1			1	2		

Prior to the current 2016-2017 period, 16 taxa have characterised the community at this site on occasions. These have comprised six 'highly sensitive', nine 'moderately sensitive', and two 'tolerant' taxa i.e. a higher proportion of 'sensitive' taxa than might be expected in the mid-reaches of a ringplain stream. Predominant taxa have included two 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*)] and three 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, and cranefly (*Aphrophila*)]; but no 'tolerant' taxa. The spring 2016 community had two characteristic taxa that were both sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.4 units indicating 'excellent' health. The summer 2017 community had the same two characteristic taxa with a slightly lower $SQMCI_s$ score of 6.7 units indicating 'very good' health (Table 49, Table 141 and Table 142).

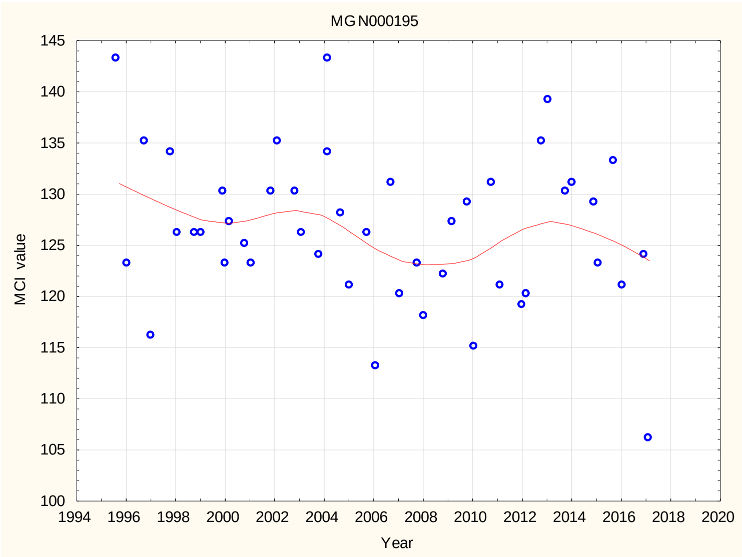
3.2.10.1.3 Predicted stream 'health'

The Manganui River site at SH3 is 8.7 km downstream of the National Park boundary at an altitude of 330 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 107 for this site. The historical site median (126 units) is a significant (Stark, 1998) 19 units above the distance predictive value. The spring 2016 survey score (124 units) was significantly higher by 17 units than the predictive value while the summer 2017 score (106 units) was not significantly different than the predictive value.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 119 units. The historical site median and spring scores were not significantly different to this value but the summer score was significantly lower (13 units). The REC predicted MCI value (Leathwick, et al. 2009) was 124 units. The historical site median and spring scores were not significantly different to this value but the summer score was significantly lower.

3.2.10.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 66). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Manganui River at SH3.



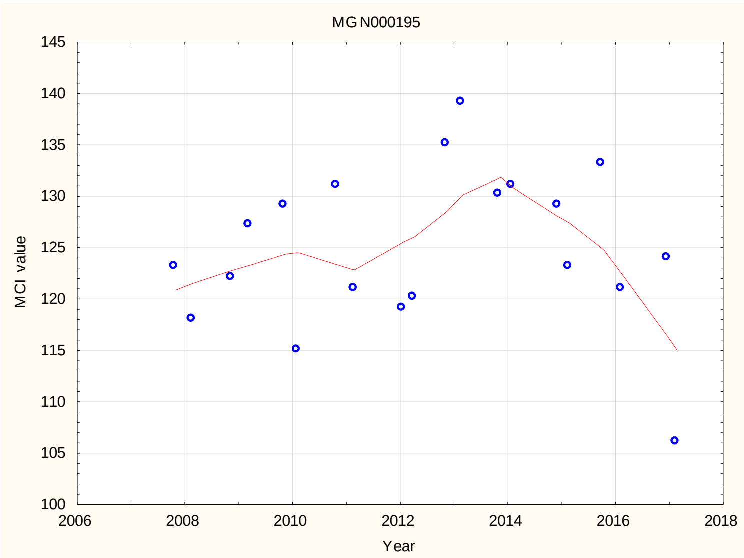
N = 46
Kendall tau = -0122
p level = 0.230
FDR p = 0.321

Figure 66 LOWESS trend plot of MCI data at the SH3 site, Manganui River

A trend of very slight overall decrease in MCI scores was identified (more accentuated over the first 12 years) which was not statistically significant for the 22-year period. The scores (range of nine units) represented no ecological importance in terms of variability. These trendline consistently indicated 'very good' generic river health (Table 2) over the entire period.

3.2.10.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 67). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Manganui River at SH3.



N = 20
Kendall tau = +0.096
p level = 0.555
FDR p = 0.758

Figure 67 LOWESS trend plot of MCI data at the SH3 site, Manganui River

A minor, positive, non-significant trend was identified for the ten year period. Thre trendline increased until 2014 before sharply decreasing from 2014 onwards. The trendline indicated 'very good' generic river health (Table 2) until 2017 when it decreased to 'good' health.

3.2.10.2 Bristol Road site (MGN000427)

3.2.10.2.1 Taxa richness and MCI

Forty-two surveys have been undertaken at this lower reach site at Bristol Road in the Manganui River between October 1995 and February 2016. These results are summarised in Table 50 together with the results from the current period, and illustrated in Figure 68.

Table 50 Results of previous surveys performed in the Manganui River at Bristol Road together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2016		Mar 2017	
		Range	Taxa no	Taxa no	Median	Taxa no	MCI	Taxa no	MCI
MGN000427	42	15-26	20	77-115	98	14	96	20	96

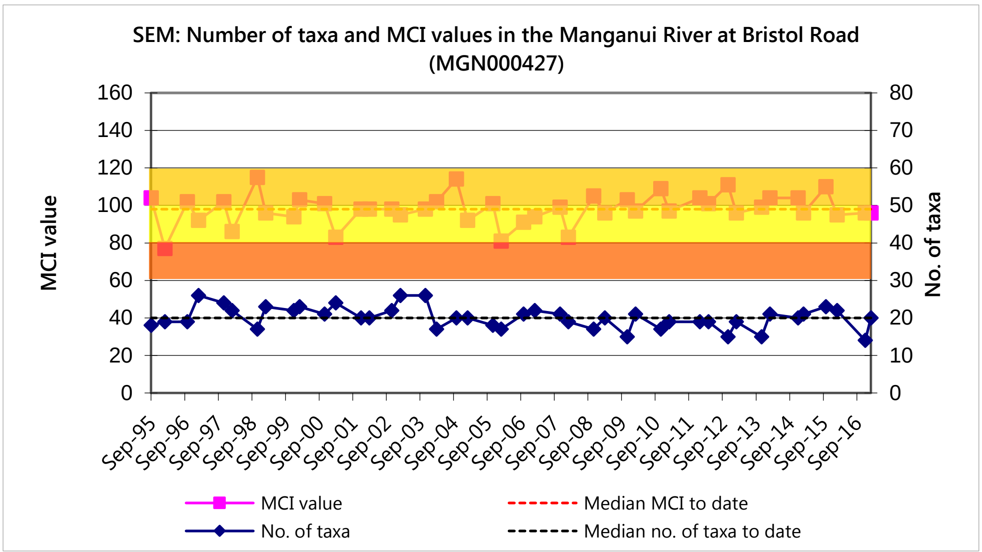


Figure 68 Numbers of taxa and MCI values in the Manganui River at Bristol Road

A moderate range of richnesses (15 to 26 taxa) has been found with a median richness of 20 taxa which is representative of typical richnesses in ringplain streams and rivers in the lower reaches. During the 2016-2017 period, the spring (14 taxa) richness was the lowest taxa richness recorded at the site to date and the summer (20 taxa) richness was typical for the site.

MCI scores have had a wide range (38 units) at this site, typical of sites in the lower reaches of streams elsewhere on the ringplain although this site was located at an atypically higher altitude of 140 m asl for a lower reach site more than 37 km downstream from the National Park boundary. The median value (98 units) has been higher than typical of lower reach ringplain sites (TRC, 2016b). The spring 2016 score (96 units) and summer score (96 units) were very similar to the historic median. These scores categorised this site as having 'fair' health generically (Table 2). The historical median score (98 units) placed this site in the 'fair' category for generic health.

3.2.10.2.2 Community composition

Characteristic macroinvertebrate taxa abundant in the communities at this site prior to the 2016-2017 period are listed in Table 51.

Table 51 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Manganui River at Bristol Road between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	2			2	5		
ANNELIDA (WORMS)	Oligochaeta	1	13	3	4	20	48		
MOLLUSCA	*Potamopyrgus*	4	1			1	2		
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	8			8	19		
	Deleatidium	8	7	11	7	25	60	XA	VA
COLEOPTERA (BEETLES)	Elmidae	6	13	5		18	43	A	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	2			2	5		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	16	13	1	30	71		A
	Costachorema	7	7			7	17		
	Hydrobiosis	5	13	1		14	33		
	Neurochorema	6	2			2	5		
	Oxyethira	2	6	1		7	17		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	17	3		20	48	A	A
	Maoridiamesa	3	12	7		19	45	A	VA
	Orthocladiinae	2	15	14	12	41	98	VA	VA
	Tanytarsini	3	7	4	2	13	31		
	Empididae	3	2			2	5		
	Muscidae	3	6			6	14		
	Austrosimulium	3	7			7	17		

Prior to the current 2016-2017 period 18 taxa have characterised the community at this site on occasions. These have comprised one ‘highly sensitive’, seven ‘moderately sensitive’, and eleven ‘tolerant’ taxa i.e. a majority of ‘tolerant’ taxa but a slightly higher proportion of ‘sensitive’ taxa than might be expected in the lower reaches of a ringplain river coincidental with this site’s relatively high elevation above sea level. Predominant taxa have included one ‘highly sensitive’ taxon (mayfly, *Deleatidium*) and two ‘tolerant’ taxa (net-building caddisfly (*Hydropsyche-Aoteapsyche*) and orthoclad midges). The spring 2016 community had five characteristic taxa with the sensitive mayfly, *Deleatidium* dominating the community which was reflected in the high $SQMCI_s$ score of 6.7 units indicating ‘very good’ macroinvertebrate community health. The summer 2017 community had six characteristic taxa with a mixture of sensitive and tolerant taxa which was reflected in the $SQMCI_s$ score of 4.5 units indicating ‘fair’ macroinvertebrate community health (Table 51).

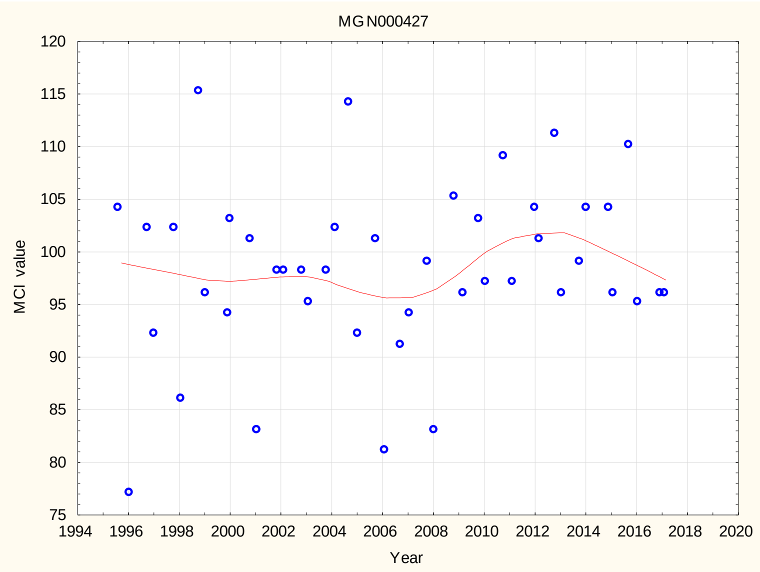
3.2.10.2.3 Predicted stream 'health'

The Manganui River site at Bristol Road is 37.9 km downstream of the National Park boundary at an altitude of 140 m asl. Relationships for ringplain streams developed between MCI and distance from the National park boundary (Stark and Fowles, 2009) predict a MCI value of 91 for this site. The historical site median, spring and summer scores were not significantly different to the predictive value.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 103 units. The historical site median, spring and summer scores were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 103 units. The historical site median, spring and summer scores were not significantly different to the REC predictive value.

3.2.10.2.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 69). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Manganui River at SH3.



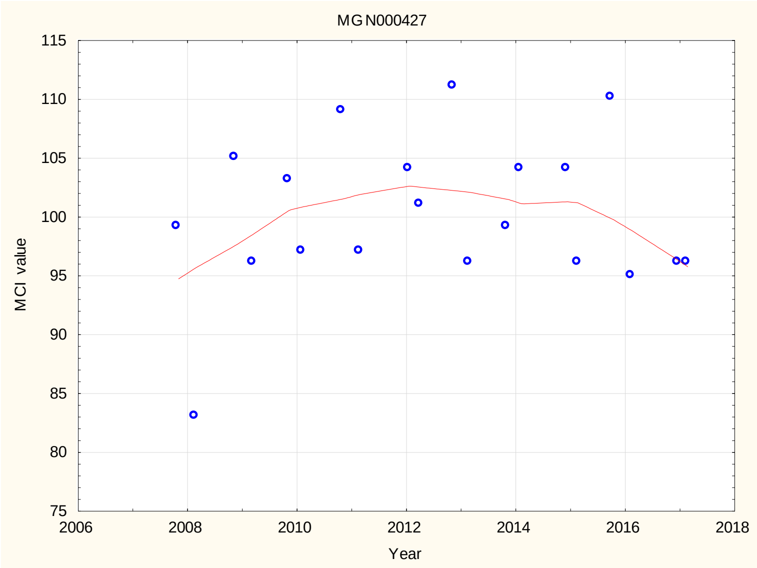
N = 44
Kendall tau = +0.095
p level = 0.363
FDR p = 0.470

Figure 69 LOWESS trend plot of MCI data at the Bristol Road site, Manganui River

The slight overall positive trend in MCI scores was not statistically significant and neither has the ecological variability in the trendline of seven units been of ecological importance. The trendline was indicative of 'fair' generic river health at this site throughout the majority of 22 year period.

3.2.10.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 70). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Manganui River at SH3.



N = 20
Kendall tau = -0.060
p level = 0.710
FDR p = 0.864

Figure 70 LOWESS trend plot of ten years of MCI data at the Bristol Road site, Manganui River

The positive non-significant trend in MCI scores was congruent with results from the full dataset. The trendline was indicative of 'fair' generic river health from 2007-2010 and then improved to 'good' health from 2010 to 2016 before decreasing to 'fair' health from 2016 onwards.

3.2.10.3 Discussion

The Manganui River at the upper site had the lowest recorded taxa richness to date for the spring survey and a relatively low taxa richness during summer. The lower site also had lowest recorded taxa richness to date for the spring survey but the summer survey showed taxa richness had increased to a typical level. Significant freshes preceding the spring survey was the likely cause of the depleted taxa richnesses on the Manganui River. The lower site was likely to be less flashy than the upper site and therefore less impacted by the significant rainfall events preceding the spring survey and hence the macroinvertebrate community at the lower site was less impacted than the upper site community.

The summer MCI score at the upper site was the lowest score recorded at the site. It appears that more 'tolerant' taxa were able to recolonise faster than more 'sensitive' taxa, albeit at low levels, after spring freshes which caused the drop in MCI score. $SQMCI_s$ scores were typical for both sites indicating 'excellent' to 'very good' health at the upper site and 'very good' to 'fair' health at the lower site for spring and summer surveys respectively. MCI score typically fell in a downstream direction in both spring (by 28 units) and summer (by 10 units), over a stream distance of 29.2 km downstream from the National Park boundary. Based on the long-term median SEM MCI scores for both sites the score fell in a downstream direction by 28 units (Appendix II).

The time trend analysis showed a no significant trends for either site for both the full and ten year dataset indicting no significant changes in macroinvertebrate health over time at the two monitored sites.

3.2.11 Mangaoraka Stream

The Mangaoraka Stream is a ringplain stream whose source is outside Egmont National Park. The stream flows from south to north and is a tributary of the Waiongna Stream where it joins close to the coast. A single site is surveyed. Due to persistently high flows no spring 2016 survey could be completed. The results found by the 2016-2017 surveys are presented in Table 143, Appendix I.

3.2.11.1 Corbett Road site (MRK000420)

3.2.11.1.1 Taxa richness and MCI

Forty-two surveys have been undertaken at this lower reach site in the Mangaoraka Stream between October 1995 and February 2016. These results are summarised in Table 52, together with the results from the current period, and illustrated in Figure 71. No spring survey was able to be completed due to persistently high flows.

Table 52 Results of previous surveys performed in Mangaoraka Stream at Corbett Road, together with summer 2017 results

Site code	SEM data (1995 to March 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
MRK000420	42	11-30	25	75-105	90	21	96

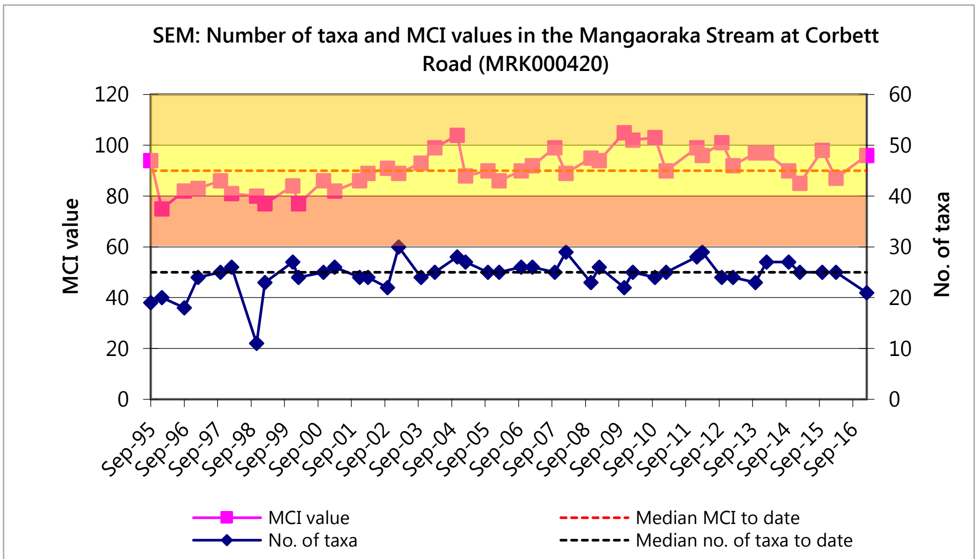


Figure 71 Numbers of taxa and MCI values in the Mangaoraka Stream at Corbett Road

A wide range of richnesses (11 to 30 taxa) has been found, with a median richness of 25 taxa (more representative of typical richnesses in the lower reaches of ringplain streams rising outside the National Park boundary). During the 2016-2017 period summer (21 taxa) richness was similar to the historical median richness.

MCI values have also had a relatively wide range (30 units) at this site to date. The median value (90 units) has been typical of lower reach sites elsewhere on the ringplain (TRC, 2016b). The summer 2017 score (96 units) was not significantly different to the historic median and categorised this site as having 'fair' health generically (Table 2). The historical median score (90 units) placed this site in the 'fair' generic health.

3.2.11.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 53.

Table 53 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Mangaoraka Stream at Corbett Road, between 1995 and February 2016 [42 surveys], and summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	1			1	2	
NEMERTEA	Nemertea	3	7			7	17	
ANNELIDA (WORMS)	Oligochaeta	1	26	7		33	79	
MOLLUSCA	*Latia*	5	2			2	5	
	Physa	3	1			1	2	
	Potamopyrgus	4	18	13	5	36	86	VA
CRUSTACEA	Ostracoda	1	1			1	2	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	14	9	1	24	57	
	Coloburiscus	7	4			4	10	
	Deleatidium	8	6	2		8	19	
	Zephlebia group	7	3			3	7	
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	13	3		16	38	
COLEOPTERA (BEETLES)	Elmidae	6	7	12	11	30	71	
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	21			21	50	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	14	15	7	36	86	A
	Costachorema	7	3			3	7	
	Hydrobiosis	5	28	2		30	71	
	Neurochorema	6	3			3	7	
	Oxyethira	2	5	1		6	14	
	Pycnocentria	7	2			2	5	
	Pycnocentrodes	5	16	10	3	29	69	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	15	6		21	50	A
	Maoridiamesa	3	8	3		11	26	
	Orthocladiinae	2	25	7		32	76	
	Tanytarsini	3	9	2		11	26	
	Empididae	3	6			6	14	
	Muscidae	3	2			2	5	
	Austrosimulium	3	13			13	31	

Prior to the current 2016-2017 period, 28 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', 13 'moderately sensitive', and 14 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included five 'moderately sensitive' taxa [mayfly (*Austroclima*), elmid beetles, free-living caddisfly (*Hydrobiosis*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)], and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges].

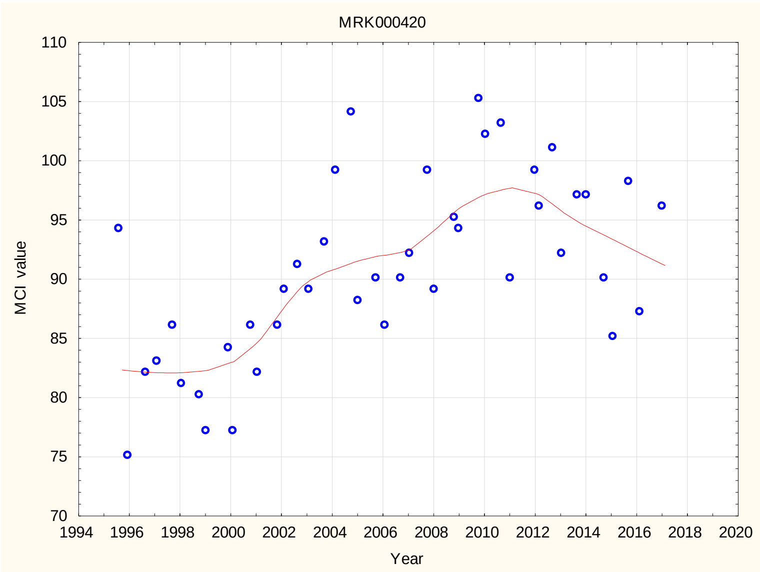
The summer 2017 community was characterised by four taxa which was a mixture of sensitive and moderate taxa which was reflected in the $SQMCI_s$ score of 4.6 units that indicated a macroinvertebrate community in 'fair' health (Table 143).

3.2.11.1.3 Predicted stream 'health'

The Mangaoraka Stream rises below the National Park boundary and the site at Corbett Road is in the lower reaches at an altitude of 60 m asl. The median value for ringplain streams of similar altitude arising outside the National Park (TRC, 2016b) was 95 units. The historical site median (90 units) and summer (96 units) scores were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical site median and summer score were also not significantly different to this value.

3.2.11.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 72). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Mangaoraka Stream at Corbett Road.



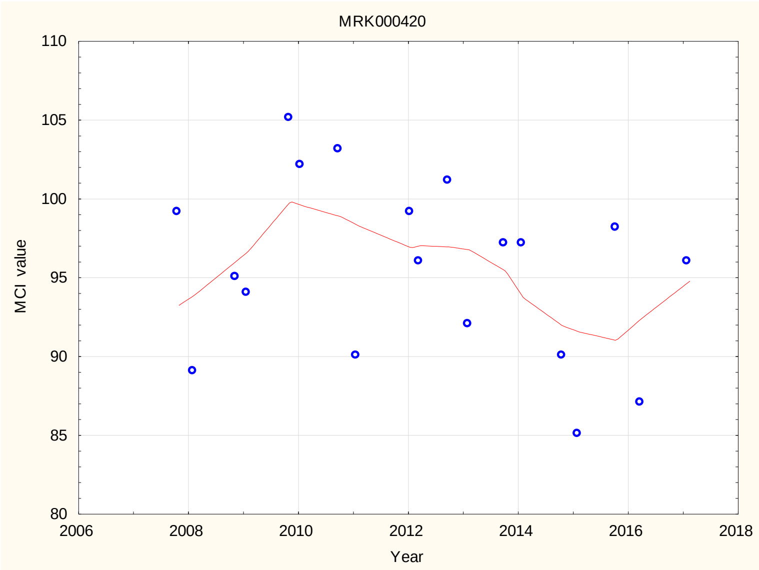
N = 43
Kendall tau = +0.445
p level < 0.001
FDR p < 0.001

Figure 72 LOWESS trend plot of MCI data at the Corbett Road site, Mangaoraka Stream

This site's MCI scores have shown a highly significant improvement (p< 0.01 after FDR). Scores improved from 1995 to 2011 but have since decreased from 2011 to 2017. However, the latest scores remain above most scores recorded prior to 2002. The trendline has varied over an ecologically important range of 16 units during the period. SEM physicochemical monitoring at this site had illustrated significant improvements in aspects of organic loadings at this site in the lower reaches of the stream prior to mid 2008. This was coincident with more rigorous surveillance monitoring of nearby quarrying and waste disposal activities and good dairy shed wastewater disposal compliance performance during that period although more recently, aspects of poorer overall water quality (i.e. increased bacteriological numbers and increasing trends in certain nutrient species) have been recorded (TRC, 2014) despite the apparent improvement in biological communities. The trendline was indicative of 'fair' generic stream health (Table 2).

3.2.11.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 73). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on ten years of SEM results (2007-2017) from the site in the Mangaoraka Stream at Corbett Road.



N = 19
Kendall tau = - 0.219
p level = 0.190
FDR p = 0.484

Figure 73 LOWESS trend plot of ten years of MCI data at the Corbett Road site

This site's MCI scores have shown a non-significant decline in MCI scores which contrasts markedly with the highly significant improvement found using the full dataset. Scores improved from 2007 to 2010, then decreased from 2010 to 2016 with a small increase in 2017. SEM physicochemical monitoring at this site had illustrated recently aspects of poorer overall water quality (i.e. increased bacteriological numbers and increasing trends in certain nutrient species) have been recorded (TRC, 2014) which probably the main reason for the decline in macroinvertebrate health. The trendline was indicative of 'fair' generic stream health (Table 2).

3.2.11.2 Discussion

No spring survey was able to be completed at this site on the Mangaoraka Stream due to persistently high flows. The site had a typical, moderate, taxa richness during summer. MCI and $SQMCI_s$ scores were also typical and indicated 'fair' health. The MCI score was also within expected parameters based on median scores and expected values from historic site, regional, and national data. Seasonal MCI values decreased between spring and summer at this lower reach site by three units (Appendix II) indicating little seasonal variation.

The time trend analysis showed a significant postive trend for the full dataset but not the ten year dataset indicting a significant improvement in macroinvertebrate health over the full duration of monitoring but no change in health recently.

3.2.12 Mangati Stream

The Mangati Stream is a small, coastal stream flowing south to north. Two sites located above and below an industrial area are sampled for SEM purposes. Due to persistently high flows no spring survey was able to be completed. The results for the summer 2017 survey are presented in Table 144, Appendix I.

3.2.12.1 Site downstream of railbrige (MGT000488)

3.2.12.1.1 Taxa richness and MCI

Forty-three surveys have been undertaken at this site in the mid reaches of this small lowland, coastal stream draining an industrial catchment between September 1995 and February 2016. These are summarised in Table 54, together with the results from the current period, and illustrated in Figure 74.

Table 54 Results of previous surveys performed in the Mangati Stream at the site downstream of the railbridge, together with summer 2017 results

Site code	SEM data (1995 to March 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI
MGT000488	43	9-29	16	56-91	78	17	73

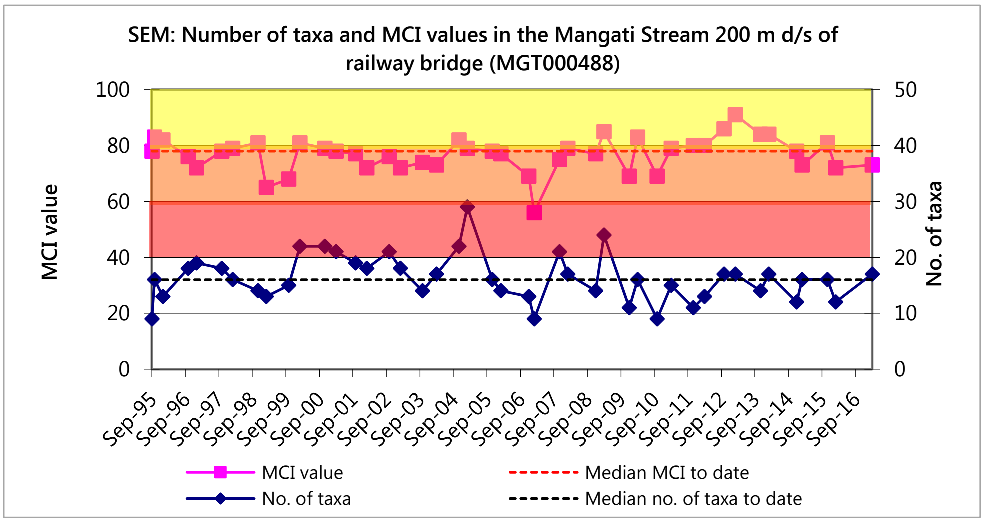


Figure 74 Numbers of taxa and MCI values in the Mangati Stream downstream of the railbridge

A very wide range of richnesses (9 to 29 taxa) has been found; with a median richness of 16 taxa which was a typical richness in Taranaki lowland coastal streams (TRC, 2016b). During the 2016-2017 period the summer survey (17 taxa) had a taxa richness typical for the site.

MCI values have had a wide range (35 units) at this site, relatively typical of a site in a small coastal stream. The median historical value (78 units) has also been typical of such streams and the summer 2017 (73 units) score was not significantly different to the historical median (Stark, 1998). These scores categorised this site as having 'poor' health in summer (Table 2). The historical median score (78 units) placed this site in the 'poor' health category for the generic method of assessment.

3.2.12.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 55.

Table 55 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Mangati Stream at the site downstream of the railbridge between 1995 and February 2016 [43 surveys], and summer 2017 survey

Taxa List		MCI	A	VA	XA	Total	%	Survey Summer 2017
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	5			5	12	
NEMERTEA	Nemertea	3	3			3	7	
ANNELIDA (WORMS)	Oligochaeta	1	18	10	8	36	84	VA
	Lumbricidae	5	1			1	2	
MOLLUSCA	*Physa*	3	3	1		4	9	
	Potamopyrgus	4	13	10	16	39	91	XA
	Sphaeriidae	3	1			1	2	
CRUSTACEA	Ostracoda	1	8	2		10	23	XA
	Paracalliope	5	9	9	19	37	86	XA
	Phreatogammarus	5	1			1	2	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	10	3		13	30	
	Zephlebia group	7	1			1	2	
HEMIPTERA (BUGS)	*Microvelia*	3	1			1	2	
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	1			1	2	
	Polyplectropus	6	1			1	2	
	Oxyethira	2	3			3	7	
DIPTERA (TRUE FLIES)	Eriopterini	5	1			1	2	
	Orthocladiinae	2	13	3	3	19	44	A
	Polypedilum	3	3			3	7	VA
	Austrosimulium	3	12	5	5	22	51	A

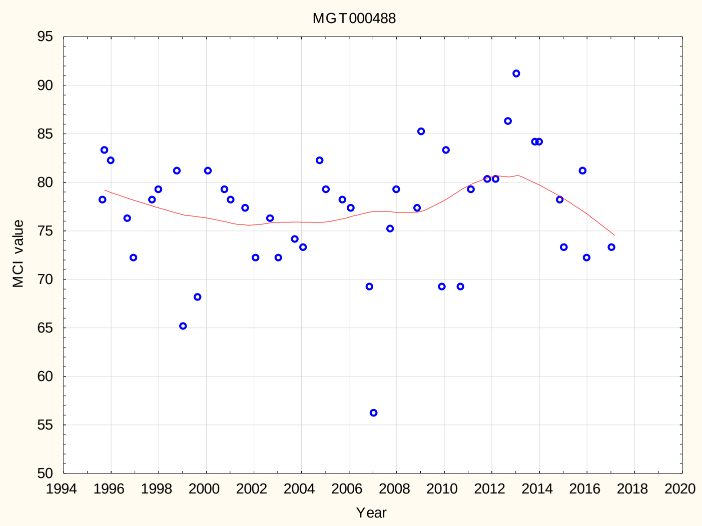
Prior to the current 2016-2017 period, 20 taxa have characterised the community at this site on occasions. These have comprised eight 'moderately sensitive' and twelve 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa as would be expected in the upper reach of a soft bottom, macrophyte dominated, small coastal stream. Predominant taxa have included only one 'moderately sensitive' taxon [amphipod (*Paracalliope*)] and three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), and sandfly (*Austrosimulium*)]. The summer 2017 community was characterised by seven characteristic taxa of which the majority were tolerant taxa which was reflected in the low $SQMCI_s$ score of 3.2 units indicating 'poor' macroinvertebrate health (Table 55) (Table 144).

3.2.12.1.3 Predicted stream 'health'

The Mangati Stream site downstream of the railbridge is in the middle reaches of a small lowland, coastal stream at an altitude of 30 m asl. The median value for lowland coastal streams of similar (TRC, 2016b) was a very low 68 units. The historical site median and summer scores were not significantly different to this value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 80 units. The historical site median and summer scores were significantly lower than this value.

3.2.12.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 75). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Mangati Stream at the site downstream of the railbridge.



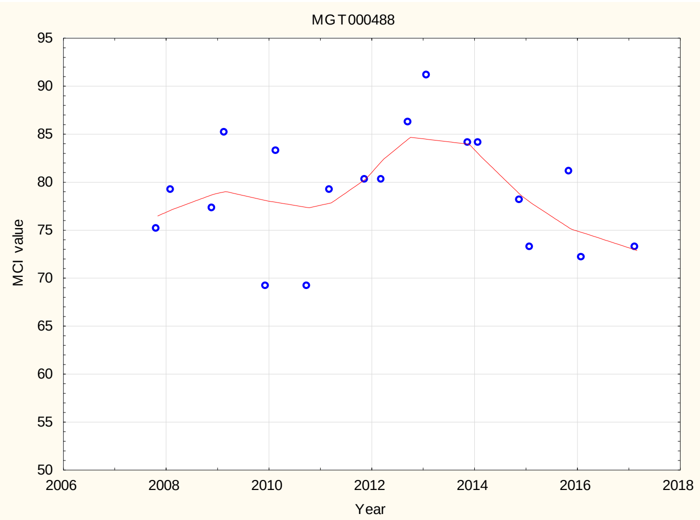
N = 44
Kendall tau = +0.081
p level = 0.438
FDR p = 0.542

Figure 75 LOWESS trend plot of MCI data at the Mangati Stream site downstream of the railbridge

There was a non-significant positive overall trend identified in the MCI scores. The trendline had a range of nine units indicative of marginal ecological importance over the period. Overall, the trendline was indicative of 'poor' generic stream health (Table 2) throughout most of the period.

3.2.12.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 76). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on ten years of SEM results (2007-2017) from the site in the Mangati Stream at the site downstream of the railbridge.



N = 19
Kendall tau = +0.024
p level = 0.887
FDR p = 0.944

Figure 76 LOWESS trend plot of ten years of MCI data at the Mangati Stream site downstream of the railbridge

There was a non-significant postive trend identified in the MCI scores, indicating no major change in the macroinvertebrate community at the site. Overall, the trendline remained indicative of 'poor' generic stream health (Table 2) throughout most of the period except between 2012-2015 when it was in 'fair' health.

3.2.12.2 Te Rima Place, Bell Block site (MGT000520)

3.2.12.3 Taxa richness and MCI

Forty-one surveys have been undertaken at this lower reach site at SH45 in the Mangati Stream between October 1995 and February 2016. These results are summarised in Table 56, together with the results from the current period, and illustrated in Figure 77.

Table 56 Results of previous surveys performed in the Mangati Stream at Te Rima Place, Bell Block together with summer 2017 results

Site code	SEM data (1995 to March 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Mar 2017	
		Range	Taxa no	Taxa no	Median	Taxa no	MCI
MGT000520	43	3-22	10	44-79	65	13	72

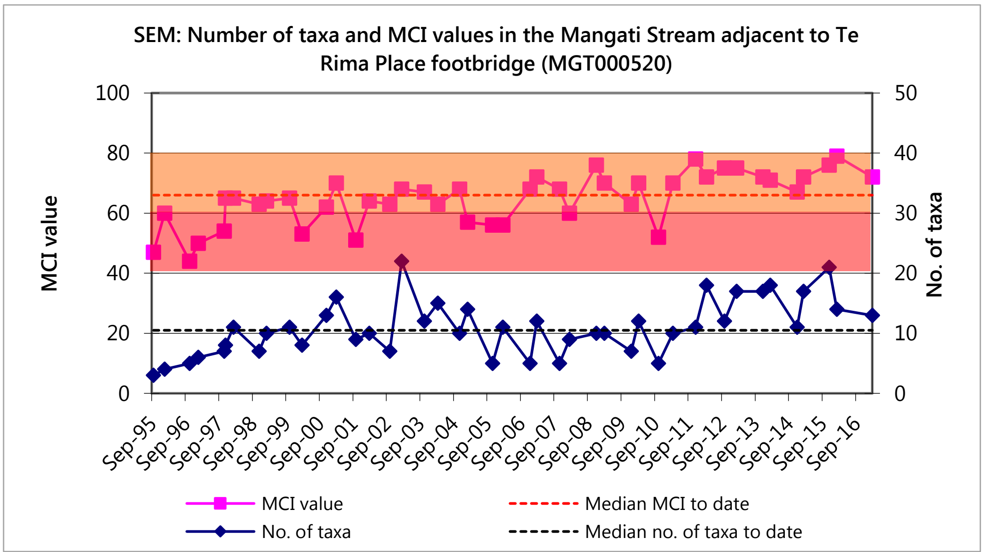


Figure 77 Numbers of taxa and MCI values in the Mangati Stream at Te Rima Place footbridge

A wide range of richnesses (3 to 22 taxa) has been found; wider than might be expected with a median richness of 10 taxa, lower than typical richnesses in the lower reaches of small lowland, coastal streams in Taranaki (17 taxa, TRC, 2016b). During the 2016-2017 period, summer (13 taxa) richness was similar to the historical median richness.

MCI scores have had a relatively wide range (35 units) at this site, typical of sites in the lower reaches of small lowland, coastal streams. The summer 2017 (72 units) score was not significantly different to the low historical median of only 65 units. The summer score categorised this site as having 'poor' health generically (Table 2). The historical median score (65 units) also placed this site in the 'poor' category for the generic method of assessment.

3.2.12.3.1 Community composition

Characteristic macroinvertebrate taxa abundant in the communities at this site prior to the 2016-2017 period are listed in Table 57.

Table 57 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Mangati Stream at Te Rima Place, Bell Block between 1995 and February 2016 [43 surveys], and by the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
NEMERTEA	Nemertea	3	1	1		2	5	
ANNELIDA (WORMS)	Oligochaeta	1	10	16	17	43	100	XA
MOLLUSCA	*Potamopyrgus*	4	1	5	19	25	58	XA
CRUSTACEA	Cladocera	5	1			1	2	
	Ostracoda	1	1			1	2	
TRICHOPTERA (CADDISFLIES)	*Oxyethira*	2	2			2	5	
	Triplectides	5	6	1		7	16	
DIPTERA (TRUE FLIES)	Orthocladiinae	2	21	6	3	30	70	A
	Empididae	3	3			3	7	
	Austrosimulium	3	6	1		7	16	

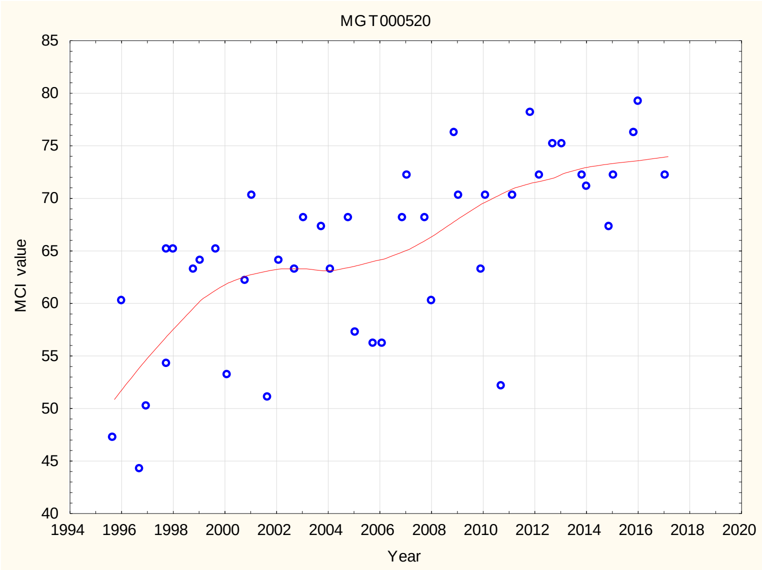
Prior to the current 2016-2017 period ten taxa have been characteristic of the community at this site. These have been comprised of two 'moderately sensitive' and eight 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a small lowland, coastal ringplain stream. Predominant taxa have included three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges]. The summer community comprised three characteristic taxa that were all tolerant taxa which was reflected in the low $SQMCI_s$ score of 2.5 units indicating poor health (Table 57) (Table 144).

3.2.12.3.2 Predicted stream 'health'

The Mangati Stream at Te Rima Place, Bell Block is in the lower, more gravel-bottomed reaches of a small lowland, coastal stream at an altitude of 20 m asl. The median value for lowland coastal streams of similar (TRC, 2016b) altitude was 79 units. The summer scores were not significantly different to this value but the historic median was significantly lower (by 14 units). The REC predicted MCI value (Leathwick, et al. 2009) was 88 units. The historical site median and summer scores were significantly lower than this value (by 23 and 16 units).

3.2.12.3.3 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 78). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Mangati Stream at Te Rima Place.



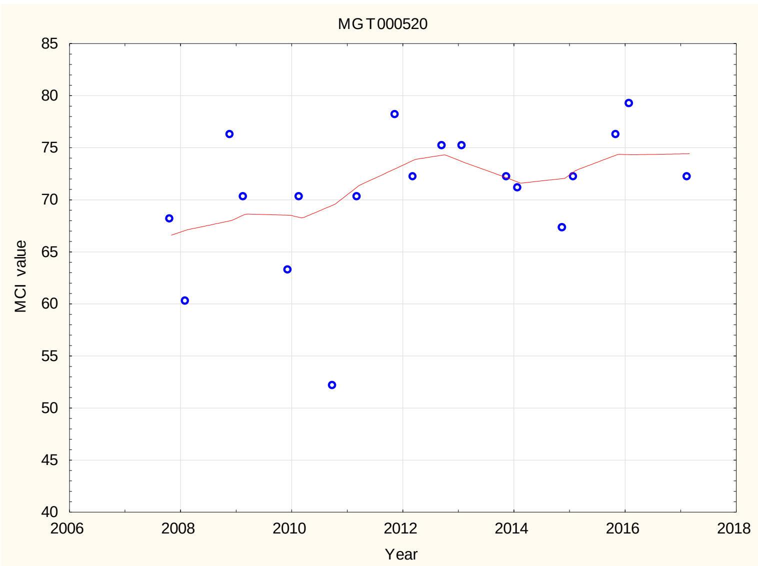
N = 44
Kendall tau = + 0.536
p level < 0.001
FDR p < 0.001

Figure 78 LOWESS trend plot of MCI data at the Mangati stream site at Te Rima Place, Bell Block

A positive temporal trend in MCI scores, statistically significant (p < 0.01) after FDR analysis indicated continued improvement coincident with better control and treatment of industrial point source discharges in the upper and mid-catchment and wetland installation (stormwater interception) in mid catchment with this improvement continuing in recent years. The trendline had a range of scores (24 units) that has been ecologically important with MCI scores indicative of a shift from 'very poor' over the first four years to 'poor' generic stream health (Table 2) during the period.

3.2.12.3.4 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 79). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on ten most recent years of SEM results (2007-2017) from the site in the Mangati Stream at Te Rima Place.



N = 19
Kendall tau = +0.351
p level = 0.036
FDR p = 0.287

Figure 79 LOWESS trend plot of ten years of MCI data at the Mangati Stream site at Te Rima Place, Bell Block

There was a positive, non-significant trend after FDR adjustment over the ten year period contrasting with the highly significant, positive trend over the full dataset. Only minor variation in the trendline has occurred over this period with a variation of about seven units over the time period though the trend was significant ($p < 0.05$) before FDR adjustment. The large improvements over the full dataset, especially over the first ten years are not so apparent in the most recent ten years hence no statistically significant trend. The trendline was indicative of 'poor' generic stream health (Table 2) during the period.

3.2.12.4 Discussion

The Mangati Stream did not have any spring sampling completed due to persistently high flows. The taxa richness during summer showed that both sites and moderate to moderately low taxa richnesses that were typical for both sites.

MCI and $SQMCI_s$ scores were typical for both sites indicating 'poor' health. There was normally a large, significant decrease (18 units) at the upper site during summer with a far smaller decrease at the lower site a (1 unit) (Appendix II).

The time trend analysis showed no significant trends for the upper site but there was a significant, positive trend at the lower site for the full dataset. This indicates that macroinvertebrate health has been improving at the lower site and suggests that improvements in water quality have largely occurred between the two sites. The lack of a significant trend for the ten year dataset may be due to the smaller sample size reducing the power to detect significant differences but it does suggest that improvements in macroinvertebrate health over the full 22 year time period are not as pronounced in the last ten years.

3.2.13 Mangawhero Stream

The Mangawhero Stream is a small stream that arises as a seepage stream draining the Ngaere swamp with a lower sub-catchment (Mangawharawhara Stream) rising on the ringplain but outside of Egmont National Park. Two sites are located on the stream, one above the discharge point of the Eltham WWTP and another close to the where it joins the Waingongoro River. The results found by the 2016-2017 surveys are presented in Table 145 and Table 146, Appendix I.

3.2.13.1 Site upstream of the Eltham Municipal WWTP discharge (MWH000380)

3.2.13.1.1 Taxa richness and MCI

Forty-two surveys have been undertaken in this mid-reach site in the Mangawhero Stream within about 3 km of the Ngaere swamp between October 1995 and February 2016. These results are summarised in Table 58, together with the results from the current period, and illustrated in Figure 80.

Table 58 Results of previous surveys performed in Mangawhero Stream upstream of Eltham WWTP, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000380	42	10-24	15	58-85	75	14	75	17	73

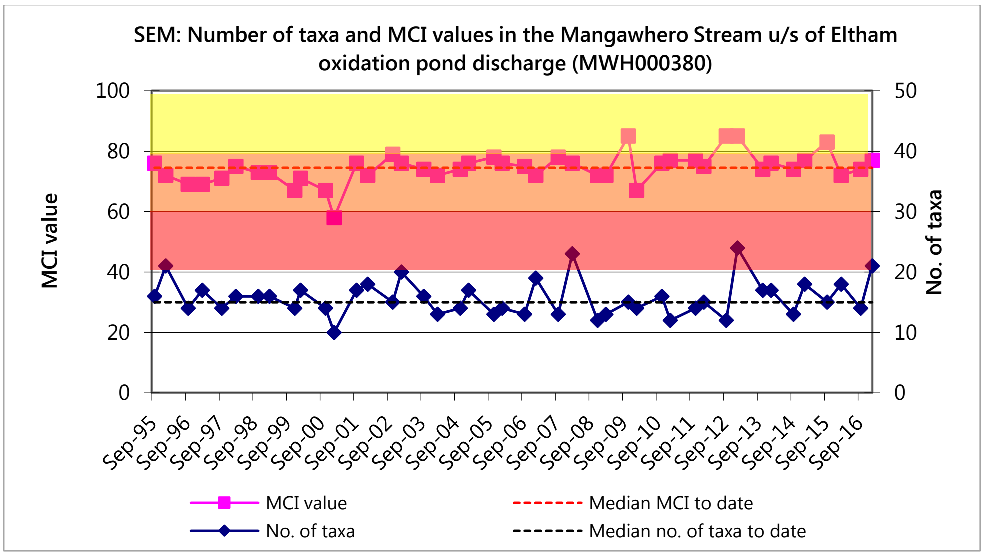


Figure 80 Numbers of taxa and MCI values in the Mangawhero Stream upstream of Eltham WWTP

A moderately wide range of richnesses (10 to 24 taxa) has been found, with a median richness of 15 taxa (more representative of typical richnesses in small swamp drainage streams where a median richness of 18 taxa has been at similar altitudes (TRC, 2016b). During the 2016-2017 period spring (14 taxa) and summer (17 taxa) richnesses were relatively similar to each other and to the historical median.

MCI values have had a moderate range (27 units) at this site. The median value (75 units) has been typical of similar non-ringplain sites elsewhere in the region. The spring 2016 (74 units) and summer 2017 (77 units) scores were not significantly different to the historical median. These scores categorised this site as having 'poor' (spring and summer) health generically (Table 2). The historical median score (75 units) placed this site in the 'poor' category for the generic method of assessment.

3.2.13.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 59.

Table 59 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Mangawhero Stream upstream of Eltham WWTP between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	1			1	2		
ANNELIDA (WORMS)	Oligochaeta	1	20	6	2	28	64	VA	
	Lumbricidae	5		1		1	2		
MOLLUSCA	*Potamopyrgus*	4	5	1		6	14	A	VA
CRUSTACEA	Ostracoda	1	6	2	2	10	23		
	Paracalliope	5	18	12	5	35	80		XA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	19	15	2	36	82		A

Taxa List		MCI	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	14	3		17	39		
	Hydrobiosis	5	6			6	14		
	Polyplectropus	6	1			1	2		
	Oxyethira	2	4			4	9		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	14	5		19	43		
	Chironomus	1	1	1		2	5		
	Maoridiamesa	3	6	1	1	8	18		
	Orthocladiinae	2	27	6	5	38	86		A
	Austrosimulium	3	14	5	1	20	45		VA

Prior to the current 2016-2017 period, 16 taxa had characterised the community at this site on occasions. These have comprised six 'moderately sensitive' and ten 'tolerant' taxa i.e. an absence of 'highly sensitive' taxa and a relatively high proportion of 'tolerant' taxa as would be expected in the drain-like reaches of a non-ringplain, swampy, seepage stream.

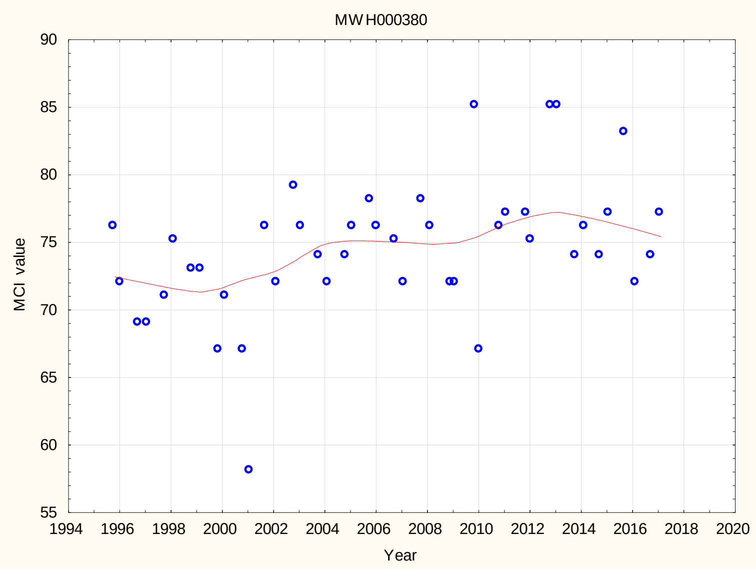
Predominant taxa have included three 'moderately sensitive' taxa [amphipod (*Paracalliope*), mayfly (*Austroclima*), and cranefly (*Aphrophila*)], and two 'tolerant' taxa [oligochaete worms and orthoclad midges]. The spring 2016 community was characterised by two historically characteristic taxa both of which were 'tolerant' taxa which was reflected in the low $SQMCI_s$ score of 2.3 units. The summer 2017 community was characterised by five taxa consisting of sensitive and 'tolerant' taxa which was reflected in the $SQMCI_s$ score of 4.5 units indicating 'fair' health (Table 59) (Table 145 and Table 146).

3.2.13.1.3 Predicted stream 'health'

The Mangawhero Stream rises as seepage from the Ngaere swamp and is not a ringplain stream at the site upstream of the Eltham WWTP. This site is at an altitude of 200 m asl and toward its upper reaches. The median value for a stream arising in smaller lowland hill country (TRC, 2016b) was 79 units. The historical, spring and summer scores were all not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The s historical, spring and summer scores were all significantly lower than the REC predictive value.

3.2.13.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 81). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the 22 years of SEM results (1995-2017) from the site in the Mangawhero Stream upstream of the Eltham WWTP discharge.



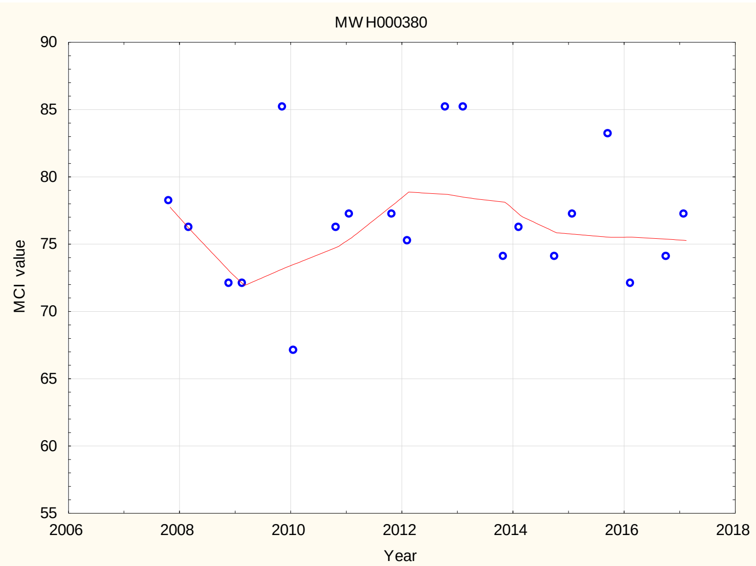
N = 44
Kendall tau = +0.324
p value = 0.002
FDR p = 0.005

Figure 81 LOWESS trend plot of MCI data at site upstream of the Eltham WWTP discharge, Mangawhero Stream

A positive, highly significant (p < 0.01, after FDR) temporal trend in MCI scores has been found over the 22-year monitoring period at this site with the early trend of slightly increasing scores having been followed by a plateauing of scores a few units above those recorded early in the programme, then another small increase and plateau in recent years. However, the narrow range of trendline scores (six units) has not been of ecological importance over the monitoring period. Trendline MCI scores consistently have been indicative of 'poor' generic stream health (Table 2) throughout the period.

3.2.13.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 82). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Mangawhero Stream upstream of the Eltham WWTP discharge.



N = 20
Kendall tau = +0.011
p value = 0.946
FDR p = 0.946

Figure 82 LOWESS trend plot of ten years of MCI data at site upstream of the Eltham WWTP discharge, Mangawhero Stream

A positive but non-significant trend in MCI scores has been found over the ten year monitoring period. Very little change in the trendline has occurred in the most recent ten year period with only six MCI units variation in the trendline highlighting the lack of variation among recent survey scores. The trendline has been indicative of 'poor' generic stream health (Table 2) throughout the period.

3.2.13.2 Site downstream of the Mangawharawhara Stream confluence (MWH000490)

3.2.13.2.1 Taxa richness and MCI

Forty-two surveys have been undertaken at this lower mid-reach site in the Mangawhero Stream between October 1995 and February 2016. These results are summarised in Table 60, together with the results from the current period, and illustrated in Figure 83.

Table 60 Results of previous surveys performed in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)						2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000490	42	13-30	20	63-102	79	24	90	21	80

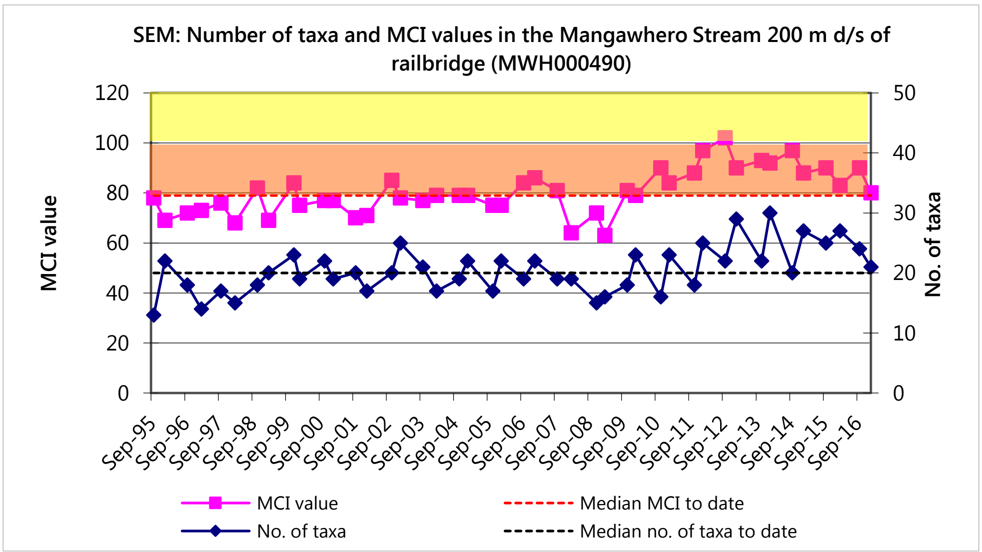


Figure 83 Numbers of taxa and MCI values in the Mangawhero Stream downstream of the railbridge and Mangawharawhara Stream confluence

A relatively wide range of richnesses (13 to 30 taxa) has been found with a moderate median richness of 20 taxa (more representative of typical richnesses in the lower-mid reaches of streams and rivers). During the 2016-2017 period spring (24 taxa) and summer (21 taxa) richnesses were slightly higher than the historic median richness.

MCI values have had a wide range (39 units) at this site, more typical of a site in the middle to lower reaches of ringplain streams. However, the median value (79 units) has been lower than typical of lower mid-reach sites elsewhere. The spring 2016 (90 units) score was significantly higher than the historic median and the summer 2017 (80 units) score was not significantly different (Stark, 1998). The MCI scores categorised the site as having 'fair' health generically (Table 2) in both spring and summer. The historical median score (79 units) placed this site in the 'poor' category for generic health.

3.2.13.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 61.

Table 61 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence, between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	1			1	2		
ANNELIDA (WORMS)	Oligochaeta	1	15	14	14	43	98	A	
MOLLUSCA	*Physa*	3	1	1		2	5		
	Potamopyrgus	4	9	6		15	34		VA
CRUSTACEA	Cladocera	5	2	1		3	7		
	Ostracoda	1	13	5	8	26	59		
	Paracalliope	5	8	11	18	37	84		VA
	Paraleptamphopidae	5	2			2	5		
	Talitridae	5	1	1		2	5		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	3			3	7		
	Deleatidium	8	4	5	4	13	30	A	
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	2			2	5		
COLEOPTERA (BEETLES)	Elmidae	6	7	3	1	11	25		A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	1			1	2		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	14	11	4	29	66	A	VA
	Costachorema	7	1			1	2		
	Hydrobiosis	5	13	1		14	32		
	Oxyethira	2	6	4		10	23		
	Pycnocentria	7	2			2	5		
	Pycnocentrodes	5	8	1	2	11	25	A	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	7	2		9	20	A	
	Chironomus	1	2			2	5		
	Maoridiamesa	3	16	5		21	48		
	Orthocladiinae	2	18	15	8	41	93	A	A
	Polypedilum	3	2			2	5	A	
	Tanypodinae	5		1		1	2		
	Tanytarsini	3	5	1		6	14	A	A
	Empididae	3	2			2	5		
	Muscidae	3	2			2	5		
	Austrosimulium	3	9	4		13	30		

Prior to the current 2016-2017 period 29 taxa have characterised the community at this site. These have comprised one 'highly sensitive', fourteen 'moderately sensitive', and fourteen 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa than might be expected at this altitude (190 m asl) in the downstream reaches of a small stream with a ringplain component. Predominant taxa have included one 'moderately sensitive' taxon [amphipod (*Paracalliope*)] and five 'tolerant' taxa [oligochaete worms, ostracod seed shrimps, net-building caddisfly (*Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)]. The spring 2016 community comprised eight characteristic taxa consisting of sensitive and 'tolerant' taxa which was reflected in the $SQMCI_s$ score of 4.1 units indicating 'fair' health. The summer 2017 community comprised six characteristic taxa consisting of sensitive and 'tolerant' taxa which was reflected in the $SQMCI_s$ score of 4.2 units indicating 'fair' health (Table 61).

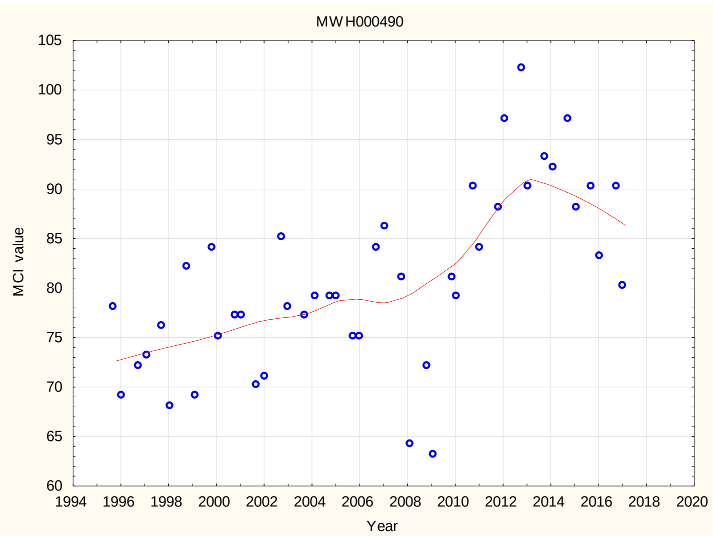
3.2.13.2.3 Predicted stream 'health'

The Mangawhero Stream site below the Mangawharawhara Stream confluence, at an altitude of 190 m asl, is in the lower reaches of a stream draining a catchment comprised of the Ngaere Swamp drainage system and a mid-reach ringplain sub-catchment with its headwaters outside the National Park.

The median value for a stream arising in smaller lowland hill country (TRC, 2016b) was 81 units. The historical, spring and summer scores were all not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 93 units. The spring score was not significantly different to this value but the historical median and summer scores were both significantly lower.

3.2.13.2.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 84). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes.



N = 44
Kendall tau = +0.479
p value < 0.001
FDR p < 0.001

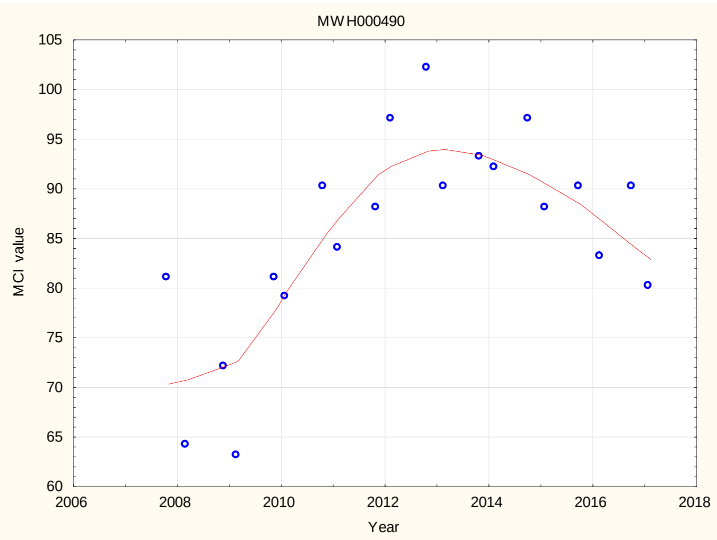
Figure 84 LOWESS trend plot of MCI data at the Mangawhero Stream site downstream of the Mangawharawhara Stream confluence

A significant (p <0.01, after FDR) improvement in MCI scores has been illustrated at this more ringplain-like site in the lower reaches of the stream near its confluence with Waingongoro River. The wide range in trendline scores (17 units) has more recently become ecologically important over this 22 year period. Scores have plateaued for the last four years after a steady improvement between 1995 and 2006 prior to the more recent marked improvement due to improved scores since the diversion of the Eltham WWTP wastes discharge out of the stream in July 2010.

The MCI scores generally have been indicative of 'poor' generic stream health (Table 2) with sporadic incursions into the 'fair' health category prior to 2010. The trendline scores remained in the 'poor' category through the period until 2010 and subsequently improved into the 'fair' category where they have since plateaued.

3.2.13.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 85). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence.



N = 20
Kendall tau = +0.329
p value = 0.043
FDR p = 0.298

Figure 85 LOWESS trend plot of ten years of MCI data at the Mangawhero Stream site downstream of the Mangawharawhara Stream confluence

A positive but non-significant increase in MCI scores occurred at this site in contrast with the significant positive result found in the full dataset. The result was significant before FDR analysis. The substaintial decline in the trendline after 2013 resulted in the non-significance. The MCI scores generally have been indicative of 'fair' generic stream health (Table 2).

3.2.13.3 Discussion

The Mangawhero Stream generally had moderate taxa richness with the upper site typically having slightly lower richness than the lower site due to poorer habitat quality and the current survey results were largely congruent with previous surveys.

MCI scores indicated 'poor' health at the upper site and 'fair' health at the lower site. The scores continue to reflect the lowland, swampy, nature of the headwaters of the Mangawhero Stream. MCI scores typically improved in a downstream direction in both spring and summer over a stream distance of 16.5 km between the upper and lower sites of this stream. This was principally as a result of improvement in physical habitat between the two sites.

The time trend analysis showed significant positive trends for both sites for the full dataset. This indicates that macroinvertebrate health has been improving at both sites over the long term. The upper site has probably improved due to riparian plantings that now provide significant shade at the site. Improvement at the lower site was consistent with the diversion of the major point source Eltham municipal wastewater discharge out of the Mangawhero Stream which was completed in June 2010. The ten year trend was less stable than the full dataset and indicates that there were large fluctuations in the health of the macroinvertebrate community which was why the trend was not significant over the shorter time period.

3.2.14 Mangorei Stream

The Mangorei Stream is a ringplain stream and tributary of the Waiwhakaiho River. A site was established in the lower reaches of the Mangorei Stream, near the confluence with the Waiwhakaiho River, for the SEM programme of 2002-2003, in recognition of the importance of this catchment as the only major inflow to the lower reaches of the river below significant HEP and New Plymouth District Council water supply abstractions. Due to persistently high flows no spring 2016 survey could be presented. The results from the survey performed in the 2016-2017 monitoring year are presented in Table 147, Appendix I.

3.2.14.1 SH3 site (MGE000970)

3.2.14.1.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken at this lower reach site in the Mangorei Stream between November 2002 and March 2016. These results are summarised in Table 62, together with the results from the current period, and illustrated in Figure 86.

Table 62 Results of previous surveys performed in the Mangorei Stream at SH 3 together with the summer 2017 result

Site code	SEM data (2002 to March 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
MGE000970	28	22-33	27	86-113	102	30	101

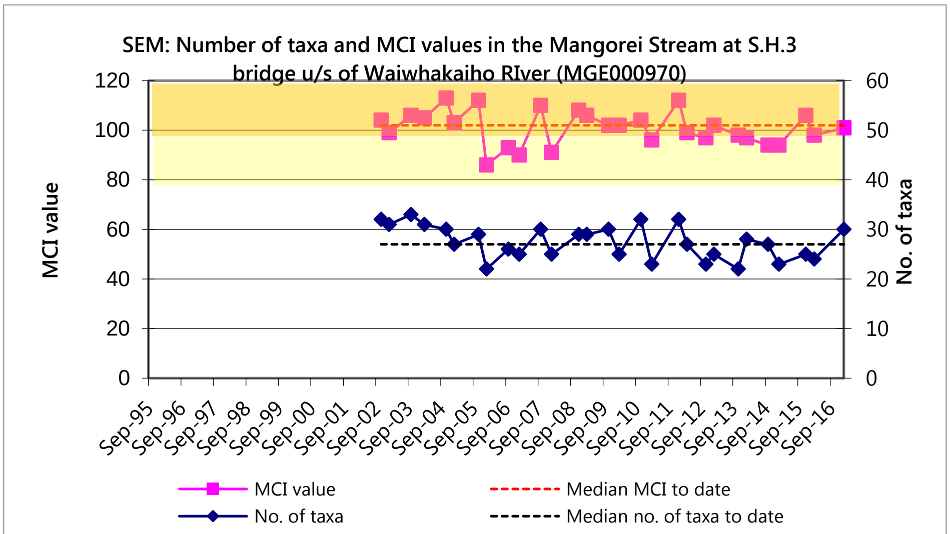


Figure 86 Numbers of taxa and MCI values in the Mangorei Stream at SH3

A moderate range of richnesses (22 to 33 taxa) has been found with a relatively high median richness of 27 taxa which was more representative of typical richnesses in upper and middle reaches of ringplain streams and rivers (TRC, 2016b). During the 2016-2017 period, summer (30 taxa) richness was similar to the historical median richness.

MCI values have had a relatively wide range (27 units) at this site, typical of a site in the lower reaches of a ringplain stream. However, the median value (102 units) has been more typical of mid-reach sites elsewhere on the ringplain. The summer 2017 (101 units) score was similar to the historical median. The score categorised this site as having 'good' health generically (Table 2). The historical median score (102 units) placed this site in the 'good' health category.

3.2.14.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 63.

Table 63 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Mangorei Stream at SH3 between 2002 and March 2016 [28 surveys], and by summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
NEMERTEA	Nemertea	3	2			2	7	
ANNELIDA (WORMS)	Oligochaeta	1	10	6	1	17	61	
MOLLUSCA	*Potamopyrgus*	4	7	2		9	32	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	14	2		16	57	
	Coloburiscus	7	8	4		12	43	
	Deleatidium	8	12	2	4	18	64	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	1			1	4	
	Zelandoperla	8	6	3		9	32	
COLEOPTERA (BEETLES)	Elmidae	6	2			2	7	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	19	1		20	71	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	19	1		20	71	VA
	Costachorema	7	9	11	5	25	89	
	Hydrobiosis	5	3			3	11	
	Neurochorema	6	8	4		12	43	
	Confluens	5	5			5	18	
	Oxyethira	2	3			3	11	A
	Pycnocentrodes	5	10	2		12	43	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	3	3		6	21	VA
	Maoridiamesa	3	9	12		21	75	A
	Orthocladiinae	2	10		1	11	39	A
	Tanytarsini	3	17	9		26	93	
	Empididae	3	12	5	1	18	64	
	Muscidae	3	6			6	21	
	Austrosimulium	3	1			1	4	VA

Prior to the current 2016-2017 period, 24 taxa have characterised the community at this site on occasions. These have comprised two 'highly sensitive', eleven 'moderately sensitive', and eleven 'tolerant' taxa i.e. an increased proportion of 'tolerant' taxa as would be expected toward the lower reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; six 'moderately sensitive' taxa [mayflies (*Austroclima* and *Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)]; and five 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), midges (orthoclads and tanytarsids), and sandfly (*Austrosimulium*)].

There were nine characteristic taxa in the summer 2017 community comprising 'sensitive' and 'tolerant' taxa which was reflected in the $SQMCI_s$ score of 4.8 units indicating 'fair' macroinvertebrate health (Table 63) (Table 147).

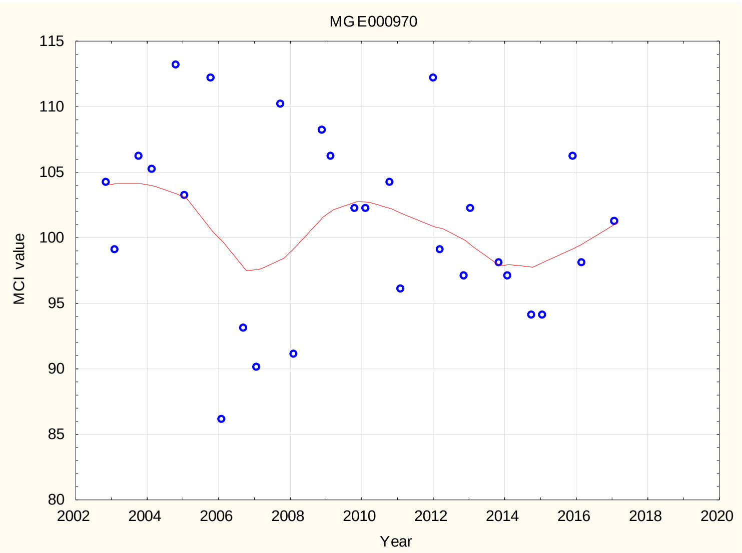
3.2.14.1.3 Predicted stream 'health

The Mangorei Stream site at SH3 is 15.6 km downstream of the National Park boundary at an altitude of 90 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 101 for this site. The historical site median and summer score was not significantly different to the distance predictive value.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 102 units. The historical site median and summer scores were significantly higher than this value. The REC predicted MCI value (Leathwick, et al. 2009) was 101 units. The historical site median and summer scores were not significantly different to this value.

3.2.14.1.4 Temporal trends in 2002 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 87). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 15 years of SEM results (2002-2017) from the site in the Mangorei Stream at SH3.



N = 29
Kendall tau = - 0.190
p level = 0.148
FDR p = 0.228

Figure 87 LOWESS trend plot of MCI data at the SH3 site, Mangorei Stream

The slightly negative decline over the 15 year period has not been a statistically significant at this site. The trendline range of scores (11 units) has been indicative of marginal ecological importance in variability. During the period, the trendline has alternated between 'fair' and 'good' generic stream health (Table 2.

3.2.14.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 88). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Mangorei Stream at SH3.

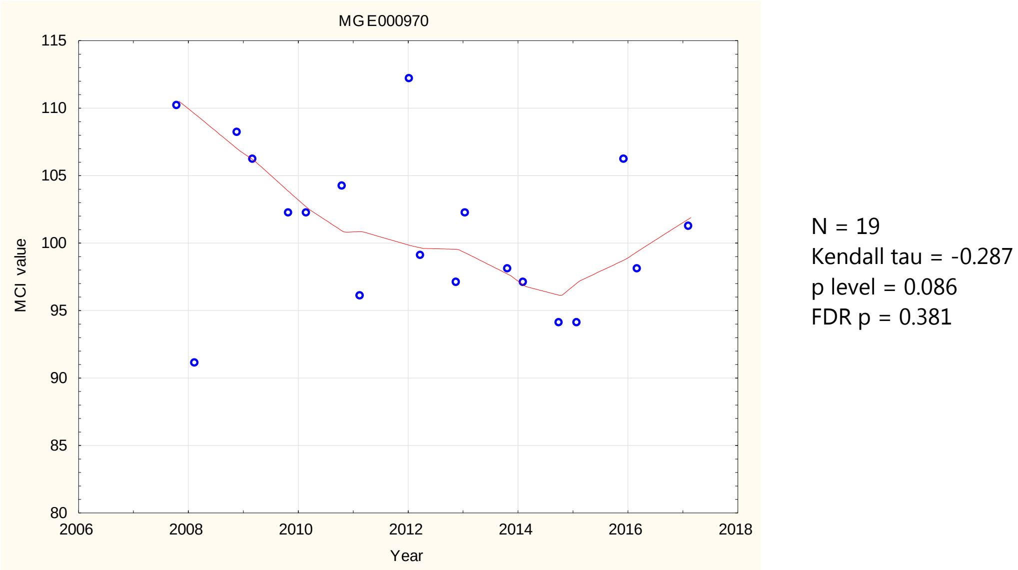


Figure 88 LOWESS trend plot of ten years of ten years of MCI data at the SH3 site

A non-significant negative trend occurred over the ten years congruent with the full dataset. The trendline showed a steady decline between 2007 and 2015 before improving from 2015 onwards. During the period, the trendline has been indicative of 'fair' to 'good' generic health (Table 2).

3.2.14.2 Discussion

The Mangorei Stream at the SEM site was found to have high taxa richness for the summer survey which was consistent with the results from past surveys. No spring survey was completed due to persistently high flows during the spring period.

The MCI score indicated 'good' health while the $SQMCI_s$ score indicated 'fair' health but overall both results indicated that macroinvertebrate community health was close to the boundary between 'good' and 'fair'.

The time trend analysis showed negative but non-significant trend for both the full and ten-year dataset indicating that over time macroinvertebrate community health had not been changing over time though there were minor fluctuations.

3.2.15 Patea River

The Patea River is a large, ringplain river that originates within Egmont National Park and flows in a southeasterly direction. Three SEM sites are located in the upper and middle reaches of the river. The results of spring and summer (2016-2017) surveys are presented in Table 148 and Table 149, Appendix I.

3.2.15.1 Barclay Road site (PAT000200)

3.2.15.1.1 Taxa richness and MCI

Forty-two surveys have been undertaken at this upper reach, shaded site adjacent to the National Park boundary in the Patea River between October 1995 and February 2016. These results are summarised in Table 64, together with the results from the current period, and illustrated in Figure 89.

Table 64 Results of previous surveys performed in the Patea River at Barclay Road, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Dec 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000200	42	24-35	30	127-145	138	27	140	27	150

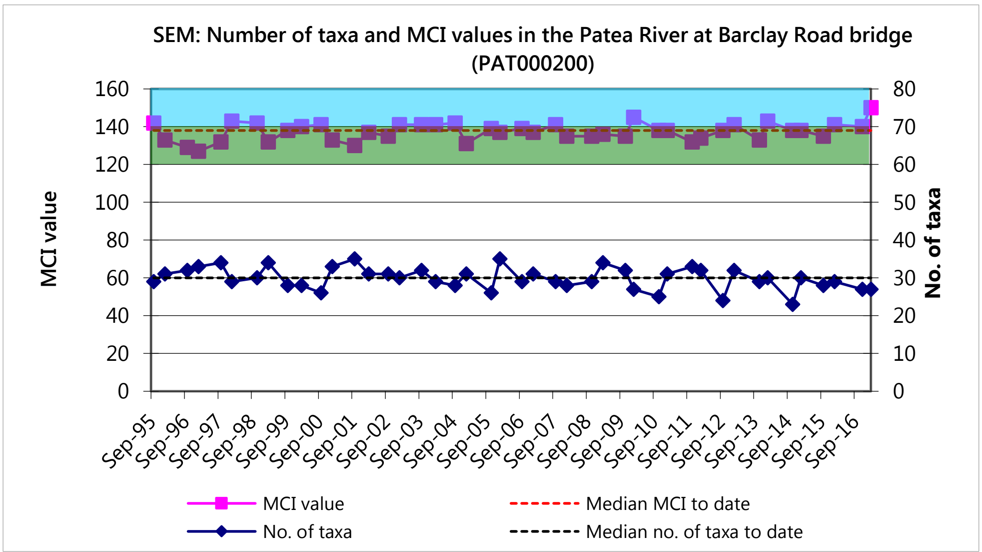


Figure 89 Numbers of taxa and MCI values in the Patea River at Barclay Road

A moderate range of richnesses (24 to 35 taxa) has been found with a relatively high median richness of 30 taxa, typical of richnesses in ringplain streams and rivers near the National Park boundary. During the 2016-2017 period spring (27 taxa) and summer (27 taxa) richnesses were similar to the historical median.

MCI values have had a moderate range (18 units) at this site, typical of a National Park boundary site. The high median value (138 units) has been typical of upper reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (140 units) and summer 2017 (150 units) scores categorised this site as having 'excellent' (spring and summer) health generically with the summer score the highest recorded MCI score to date at this site (Table 2). The historical median score (138 units) placed this site in the 'very good' for generic health.

3.2.15.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 65.

Table 65 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Patea River at Barclay Road between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	7	1		8	19		
	Coloburiscus	7	11	22	9	42	100	A	A
	Deleatidium	8	6	7	29	42	100	XA	VA
	Nesameletus	9	6			6	14		
PLECOPTERA (STONEFLIES)	*Acroperla*	5	1			1	2		
	Austroperla	9	1			1	2		
	Megaleptoperla	9	15			15	36		
	Zelandobius	5	16			16	38		
	Zelandoperla	8	24	9		33	79	A	A
COLEOPTERA (BEETLES)	Elmidae	6	31	4		35	83	A	A
	Hydraenidae	8	13			13	31		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	7			7	17		
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	1	1		2	5		
	Hydrobiosis	5	1			1	2		
	Hydrobiosella	9	2			2	5		
	Hydropsyche (Orthopsyche)	9	26	2		28	67		A
	Beraeoptera	8	16	4		20	48		
	Helicopsyche	10	14	1		15	36		
	Olinga	9	1			1	2		
	Zelolessica	7	1			1	2		A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	31	6		37	88		
	Orthocladiinae	2	15	1		16	38		
	Polypedilum	3	3			3	7		

Prior to the current 2016-2017 period, 23 taxa had characterised the community at this site on occasions. These have comprised eleven 'highly sensitive', ten 'moderately sensitive', and only two 'tolerant' taxa i.e. a majority of 'highly sensitive' taxa as would be expected near the National Park boundary of a ringplain river. Predominant taxa have included three 'highly sensitive' taxa [mayfly (*Deleatidium* on every sampling occasion), stonefly (*Zelandoperla*), and caddisfly (*Hydropsyche-Orthopsyche*)]; three 'moderately sensitive' taxa [mayfly (*Coloburiscus* on every occasion), elmid beetles, and cranefly (*Aphrophila*)]; but no 'tolerant' taxa.

The spring 2016 community had four characteristic taxa which were all sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.8 units indicating 'excellent' health. The summer 2017 community had six characteristic taxa which were also all sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.7 units indicating 'excellent' health community (Table 148 and Table 149).

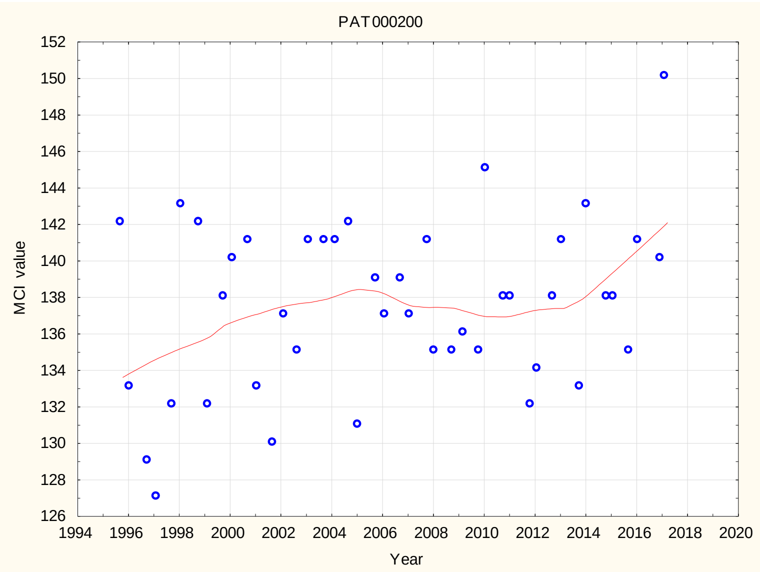
3.2.15.1.3 Predicted stream 'health'

The Patea River site at Barclay Road is 1.9 km downstream of the National Park boundary at an altitude of 500 m asl. Some bush cover extends from the National Park adjacent to most of the reach upstream of this site which is situated in farmland. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value 125 distance for this site. The historical site median (138 units), spring and summer scores were all significantly higher than the distance predictive value.

The median value for ringplain streams of similar altitude (TRC, 2016b) was 134 units. The historical spring, summer and historical median scores were all not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 129 units. The historical site median was not significantly different to this value but the spring and summer scores were both significantly higher.

3.2.15.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 90). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Patea River at Barclay Road.



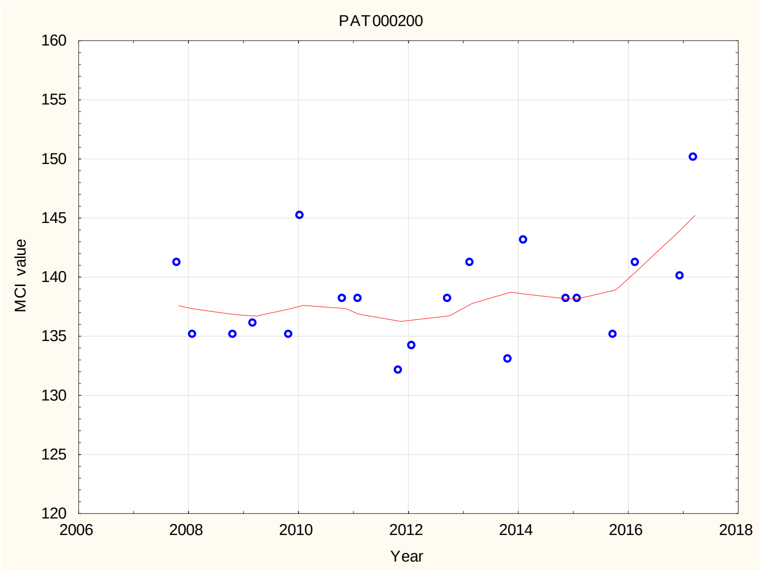
N = 44
Kendall tau = +0.130
p value = 0.213
FDR p = 0.304

Figure 90 LOWESS trend plot of MCI data at the Barclay Road site, Patea River

No statistically significant temporal trend in MCI scores has been found at this upper catchment site over the twenty-two year monitoring period during which there has been a minimal overall trend of slight improvement. The trendline range (eights units) did show minor ecological importance. The trendline has indicated 'very good' generic river health untill 2016 when when it improved to 'excellent' (Table 2) at this relatively pristine site just outside the National Park boundary.

3.2.15.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 91). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2006-2016) from the site in the Patea River at Barclay Road.



N = 20
Kendall tau = +0.227
p value = 0.161
FDR p = 0.467

Figure 91 LOWESS trend plot of MCI data at the Barclay Road site, Patea River

No statistically significant trend in MCI scores has been found at this upper catchment site over the ten year monitoring period congruent with the results of the full dataset. Minimal change in MCI scores has occurred. The trendline range of scores have consistently indicated 'very good' generic river health (Table 2).

3.2.15.2 Swansea Road site (PAT000315)

3.2.15.2.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Patea River at this mid-reach site at Swansea Road, Stratford between October 1995 and February 2016. These results are summarised in Table 66, together with the results from the current period, and illustrated in Figure 92.

Table 66 Results of previous surveys performed in the Patea River at Swansea Road, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Dec 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000315	42	20-32	26	99-130	111	22	116	20	120

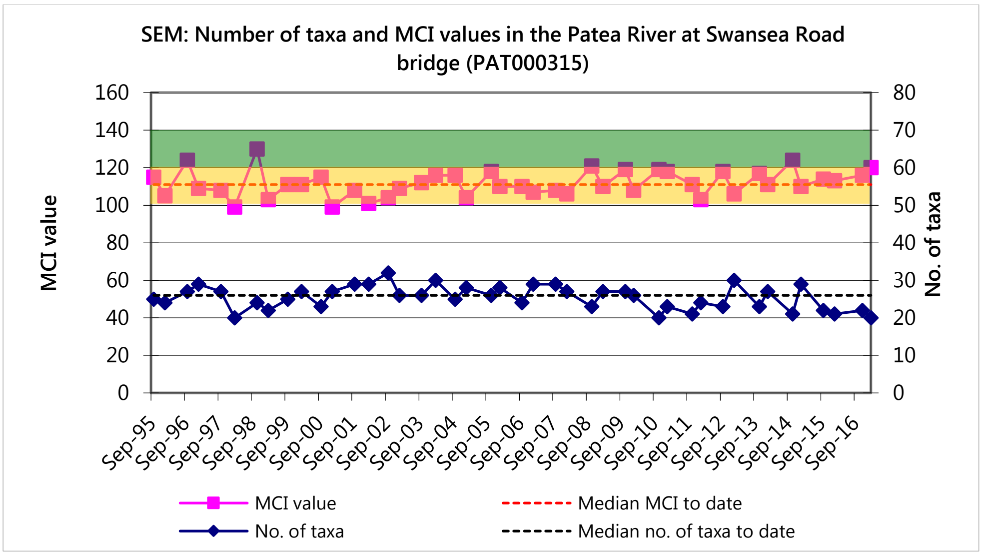


Figure 92 Numbers of taxa and MCI values in the Patea River at Swansea Road

A moderate range of richnesses (20 to 32 taxa) has been found, with a median richness of 26 taxa, typical of richnesses in the mid reaches of ringplain streams and rivers. During the 2016-2017 period, spring (22 taxa) and summer (20 taxa) richnesses were slightly lower than the median taxa number.

MCI values have had a relatively wide range (31 units) at this site, more so than typical of many sites in the mid reaches of ringplain rivers. The median value (111 units) has been relatively typical of scores in mid-reach sites elsewhere on the ringplain. The spring 2016 (116 units) and summer 2017 (120 units) scores were not significantly different to the historical median. These scores categorised this site as having 'good' (spring) and 'very good' (summer) health generically (Table 2). The historical median score (111 units) placed this site in the 'good' category for generic health.

3.2.15.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 67.

Table 67 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Patea River at Swansea Road between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	7	1		8	19		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	13	1		14	33		
	Coloburiscus	7	8	25	9	42	100	VA	VA
	Deleatidium	8	10	4	21	35	83	XA	VA
	Nesameletus	9	13	3		16	38	A	VA
PLECOPTERA (STONEFLIES)	*Acroperla*	5	5			5	12		
	Zelandoperla	8	10	1		11	26		
COLEOPTERA (BEETLES)	Elmidae	6	19	7		26	62		A
	Hydraenidae	8	9			9	21		

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	16	1		17	40		A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	12	12	6	30	71	A	VA
	Costachorema	7	21			21	50		
	Hydrobiosis	5	4	1		5	12		
	Neurochorema	6	4			4	10		
	Beraeoptera	8	8	1		9	21		VA
	Confluens	5	1			1	2		
	Pycnocentrodes	5	5			5	12		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	23	14		37	88		
	Eriopterini	5	1			1	2		
	Maoridiamesa	3	14	9	2	25	60		
	Orthocladiinae	2	22	6	8	36	86		
	Tanytarsini	3	7	3		10	24		
	Muscidae	3	2			2	5		
	Austrosimulium	3	8	2		10	24		

Prior to the current 2016-2017 period, 23 taxa had characterised the community at this site on occasions. These have comprised five 'highly sensitive', twelve 'moderately sensitive', and seven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increase in 'tolerant' taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Costachorema*), and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)].

The spring 2016 community comprised mostly sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.6 indicating 'excellent' health. The summer 2017 community also comprised mostly sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.1 units indicating 'excellent' health (Table 67) (Table 148 and Table 149).

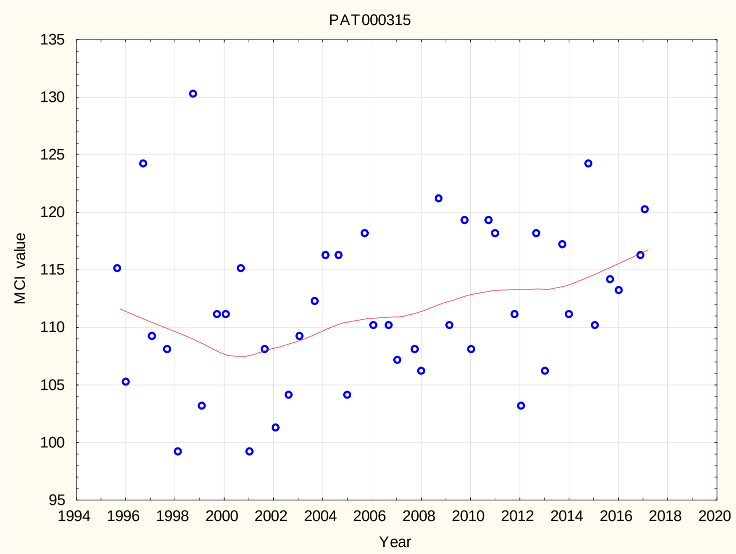
3.2.15.2.3 Predicted stream 'health'

The Patea River site at Swansea Road, Stratford is 12.4 km downstream of the National Park boundary at an altitude of 300 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 103 units for this site. The historical site median (111) was a non-significant eight units higher than the distance predictive value. The spring 2016 survey (116 units) and summer 2017 survey (120 units) scores were both significantly higher than the distance predictive value.

The median value for ringplain streams of similar altitude (TRC, 2016b) was 119 units. The historical spring, summer and historical median scores were all not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 112 units. The historical spring, summer and historical median scores were also all not significantly different to this value.

3.2.15.2.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 93). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Patea River at Swansea Road.



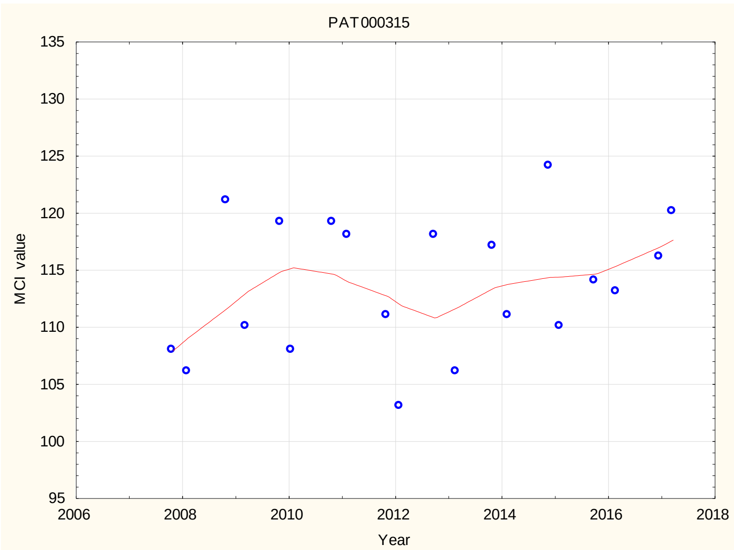
N = 44
Kendall tau = +0.211
p value = 0.044
FDR p = 0.076

Figure 93 LOWESS trend plot of MCI data at the Swansea Road site, Patea River

The small positive temporal trend in MCI scores was not statistically significant over the 22 year period after FDR was applied to the p value. The trendline range of scores (six units) was of no ecological importance. The trendline range of scores consistently indicated 'good' generic river health (Table 2) throughout the monitoring period.

3.2.15.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 94). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on ten years of SEM results (2007-2017) from the site in the Patea River at Swansea Road.



N = 20
Kendall tau = +0.139
p value = 0.391
FDR p = 0.645

Figure 94 LOWESS trend plot of ten years of MCI data at the Swansea Road site, Patea River

The small positive trend in MCI scores was not statistically significant over the ten year period congruent with the results of the full dataset. The trendline range of scores consistently indicated 'good' generic river health (Table 2) throughout the monitoring period.

3.2.15.3 Skinner Road site (PAT000360)

3.2.15.3.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Patea River at this mid-reach site at Skinner Road (some 6 km downstream of the Swansea Road, Stratford site), between October 1995 and February 2016. These results are summarised in Table 68, together with the results from the current period, and illustrated in Figure 96.

Table 68 Results of previous surveys performed in the Patea River at Skinner Road, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Dec 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000360	42	15-33	23	86-105	98	20	96	28	96

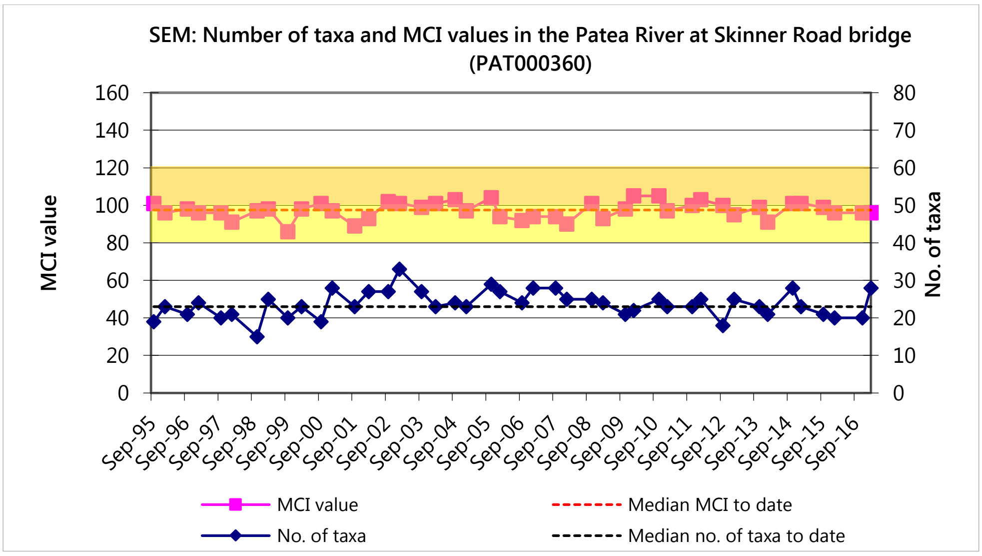


Figure 95 Numbers of taxa and MCI values in the Patea River at Skinner Road

A wide range of richnesses (15 to 33 taxa) has been found with a median richness of 23 taxa (more representative of typical richnesses in the mid-reaches of ringplain streams and rivers). During the 2016-2017 period spring (20 taxa) and summer (28 taxa) richnesses were within five taxa of the historical median.

MCI values have had a moderate range (19 units) at this site, typical of sites in the mid-reaches of ringplain streams and rivers. The median value (98 units) has been relatively typical of the scores at mid-reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (96 units) and summer 2017 (96 units) scores were not significantly different to the historical median. They categorised this site as having 'fair' (spring and summer) health generically (Table 2). The historical median score (98 units) placed this site in the 'fair' category for generic health.

3.2.15.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 69.

Table 69 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Patea River at Skinner Road between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	5			5	12		
ANNELIDA (WORMS)	Oligochaeta	1	14	7	7	28	67	XA	
MOLLUSCA	*Potamopyrgus*	4	7	3		10	24		
CRUSTACEA	*Paracalliope*	5	1			1	2		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	1			1	2		
	Coloburiscus	7	13	2		15	36		
	Deleatidium	8	4	9	8	21	50	A	
PLECOPTERA (STONEFLIES)	*Acroperla*	5	2			2	5		
COLEOPTERA (BEETLES)	Elmidae	6	17	16		33	79		A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	18			18	43		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	17	12	6	35	83	A	A
	Costachorema	7	13			13	31		
	Hydrobiosis	5	16	4		20	48		
	Oxyethira	2	3	1		4	10		
	Pycnocentrodes	5	8	2		10	24		A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	20	11	1	32	76	A	
	Maoridiamesa	3	11	17	6	34	81	VA	A
	Orthocladiinae	2	18	18	6	42	100		A
	Tanytarsini	3	15	6		21	50	A	A
	Empididae	3	2			2	5		
	Muscidae	3	8			8	19		A
	Austrosimulium	3	8			8	19		

Prior to the current 2016-2017 period, 22 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive' taxon, but ten 'moderately sensitive' and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportions of 'moderately sensitive' and 'tolerant' taxa as would be expected in the mid-reaches of a ringplain river. Predominant taxa have included no 'highly sensitive' taxa, three 'moderately sensitive' taxa [elmid beetles, free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)], and four 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)].

The spring 2016 community consisted of six characteristic taxa which was dominated by tolerant taxa which was reflected in the $SQMCI_s$ score of 1.9 units that indicated 'very poor' macroinvertebrate health. The summer 2017 community consisted of seven characteristic taxa which were a mixture of sensitive and tolerant taxa which was reflected in the $SQMCI_s$ score of 4.2 units indicating 'fair' macroinvertebrate health (Table 69) (Table 148 and Table 149).

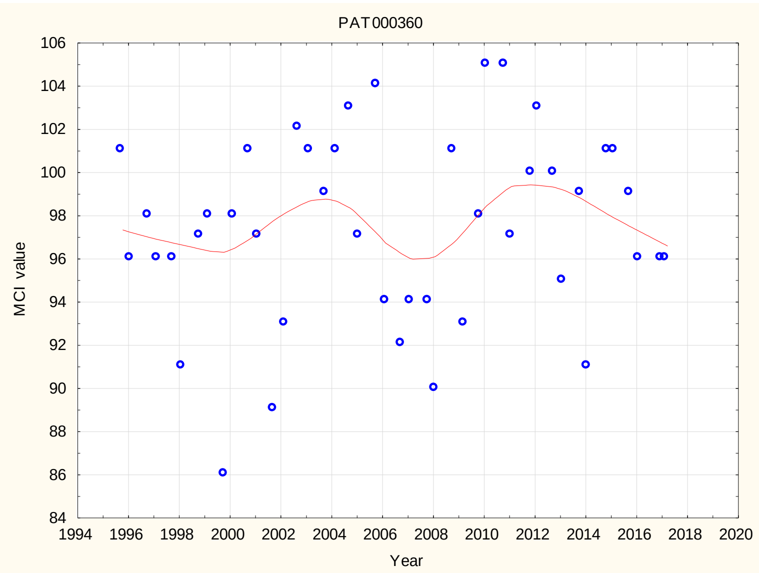
3.2.15.3.3 Predicted stream 'health'

The Patea River site at Skinner Road is 19.2 km downstream of the National Park boundary at an altitude of 240 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 99 for this site. The historical site median (98) was only one unit lower than the distance predictive value. The spring 2016 and summer 2017 surveys' scores were also both not significantly different to the predicted distance value.

The median value for ringplain streams of similar altitude (TRC, 2016b) was 101 units. The historical spring, summer and historical median scores were all not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 109 units. The historical, spring and summer scores were also not significantly different to this value.

3.2.15.3.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 96). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Patea River at Skinner Road.



N = 44
Kendall tau = +0.082
p value = 0.433
FDR p = 0.549

Figure 96 LOWESS trend plot of MCI data at the Skinner Road site, Patea River

The small positive temporal trend in MCI scores over the 22-year period has not been statistically significant. An apparent decline in scores between 2004 and 2008 has been followed by some improvement followed by a more recent plateau in scores. The very small range exhibited by the trendline (three units) has been of no ecological importance over the period. The trendline consistently indicated 'fair' generic river health (Table 2).

3.2.15.3.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 97). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Patea River at Skinner Road.

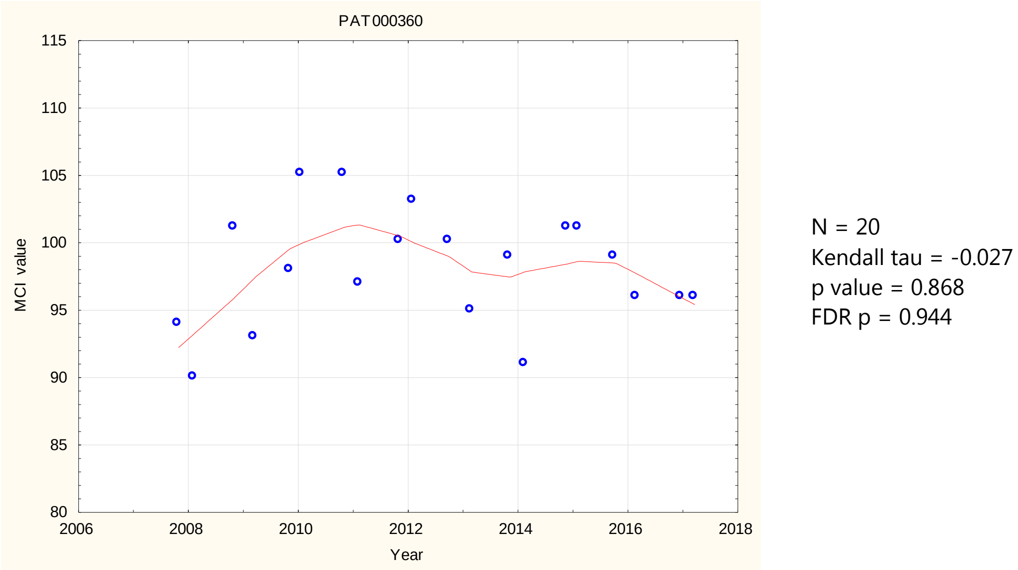


Figure 97 LOWESS trend plot of ten years of MCI data at the Skinner Road site, Patea River

The small negative trend in MCI scores over the ten-year period was not statistically significant. There was some improvement from 2007 to 2011 followed by a slight decrease and then a more recent plateau in scores. The trendline generally indicated 'fair' generic river health (Table 2).

3.2.15.3.6 Discussion

The Patea River at the SEM sites was found to have moderate to moderately high taxa richnesses which was consistent with the results from past surveys. As was typical for the river taxa richness decreased slightly in a downstream direction.

The upper site had 'excellent' macroinvertebrate community health with the highest recorded MCI score to date recorded during the summer survey. The middle site had generally 'very good' health with $SQMCI_s$ scores indicating 'excellent' health but MCI scores close to the boundary between 'very good' to 'good'. The lower site was in the poorest condition with MCI scores and the summer $SQMCI_s$ score indicating 'fair' health. However, the spring $SQMCI_s$ score was very low, indicating 'very poor' health. This was, largely due to the high abundances of pollution tolerant oligochate worms and chironomid midges coincident with higher levels of fine sediment comprising the substrate and higher periphyton abundance.

Overall, MCI scores fell in a downstream direction between the upper site and the furthest downstream site by 44 units in spring and 54 units in summer, over a river distance of 17.3 km indicating a significant deterioration in macroinvertebrate community health between the upper and lower site. This was consistent with previous surveys with a median decrease of 42 units recorded over all 44 surveys.

The time trend analysis showed no significant trends for both the full and ten year dataset at all three sites indicating that over time macroinvertebrate community health had not been significantly improving or deteriorating.

3.2.16 Punehu Stream

The Punehu Stream is a ringplain stream whose source is located within Egmont National Park and flows from north to south with its mouth located east of the town of Opunake. There are two SEM sites, one located in its upper middle reaches and the other located in its lower reaches. The results of the spring and summer (2016-2017) surveys are summarised in Table 150 and Table 151, Appendix I.

3.2.16.1 Wiremu Road site (PNH000200)

3.2.16.1.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Punehu Stream between October 1995 and March 2016 at this open, upper mid-reach site in farmland, 4 km downstream of the National Park These results are summarised in Table 70 together with the results from the current period, and illustrated in Figure 98.

Table 70 Results of previous surveys performed in the Punehu Stream at Wiremu Road together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000200	42	19-31	27	104-137	123	21	123	18	127

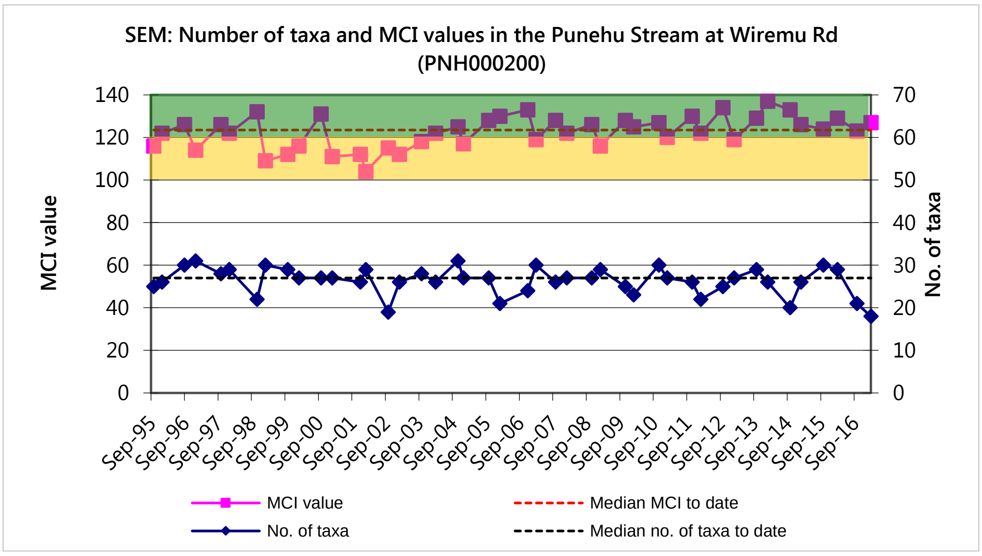


Figure 98 Numbers of taxa and MCI values in the Punehu Stream at Wiremu Road

A moderate range of richnesses (19 to 31 taxa) has been found with a median richness of 27 taxa (more representative of typical richnesses in the mid reaches of ringplain streams and rivers (TRC, 2016b)). During the 2016-2017 period, spring richness (21 taxa) and summer (18 taxa) richnesses were moderate and similar to the median richness.

MCI values have had a moderate range (33 units) at this site, typical of a site in the (upper) mid reaches of a ringplain stream in more open farmland. The median value (123 units) has been typical of mid reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (123 units) and summer 2017 (127 units) scores were not significantly different to the historical median (Stark, 1998). These scores categorised this site as having 'very good' generic health (Table 2) in spring and summer. The historical median score (123 units) placed this site in the 'very good' category for the generic health.

3.2.16.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 71.

Table 71 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Punehu Stream at Wiremu Road between 1995 and March 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	4			4	10		
MOLLUSCA	*Potamopyrgus*	4	1			1	2		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	7			7	17	A	
	Coloburiscus	7	24	14	1	39	93	VA	
	Deleatidium	8	7	8	27	42	100	XA	VA
	Nesameletus	9	19	17	1	37	88	A	VA
PLECOPTERA (STONEFLIES)	*Acroperla*	5	2			2	5		
	Megaleptoperla	9	6			6	14		
	Zelandoperla	8	18	11	2	31	74		
COLEOPTERA (BEETLES)	Elmidae	6	20	15	7	42	100	A	
	Hydraenidae	8	5			5	12		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	4			4	10		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	17	12		29	69	A	A
	Costachorema	7	18	3		21	50		
	Hydrobiosis	5	11			11	26		
	Beraeoptera	8	9	6	5	20	48	VA	
	Helicopsyche	10	4			4	10		
	Olinga	9	2			2	5		
	Oxyethira	2	1			1	2		
	Pycnocentrodes	5	12	10	3	25	60	VA	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	5			5	12		
	Eriopterini	5	8			8	19		
	Maoridiamesa	3	9	6	2	17	40		VA
	Orthocladiinae	2	16	3	1	20	48		VA
	Empididae	3	1			1	2		

Prior to the current 2016-2017 period, 25 taxa have characterised the community at this site on occasions. These have comprised eight 'highly sensitive', ten 'moderately sensitive', and seven 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the (upper) mid reaches of a ringplain stream. Predominant taxa have included three 'highly sensitive' taxa [mayflies (*Deleatidium* on every occasion, and *Nesameletus*) and stonefly (*Zelandoperla*)]; four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles (on very occasion), stony-cased caddisfly (*Pycnocentrodes*), and free-living caddisfly (*Costachorema*)]; and two 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and orthoclad midges].

The spring community had eight characteristic taxa which comprised mostly sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.3 units indicating 'excellent' health. The summer community had five characteristic taxa which comprised a mixture of sensitive and tolerant taxa which was reflected in the $SQMCI_s$ score of 5.6 units indicating 'good' health (Table 71) (Table 150 and Table 151).

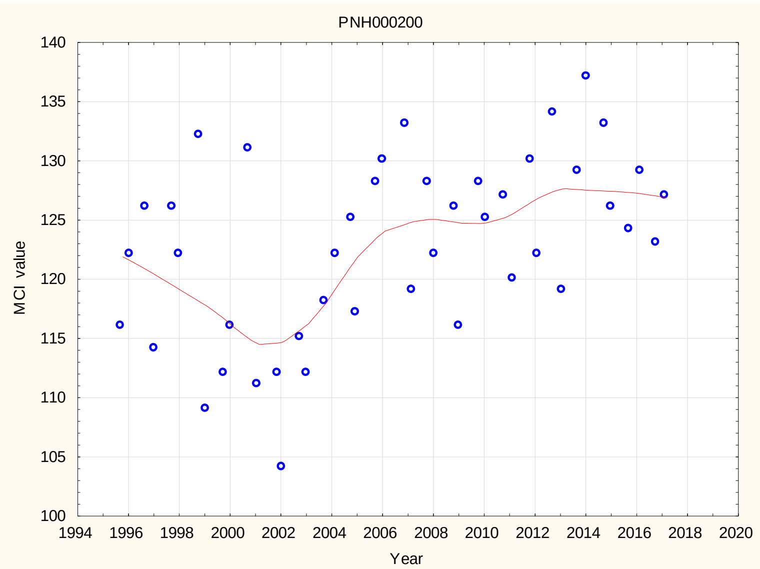
3.2.16.1.3 Predicted stream 'health'

The Punehu Stream site at Wiremu Road is 4.4 km downstream of the National Park boundary at an altitude of 270 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 115 for this site. The historical site median (123 units) was a non-significant eight units above the distance predictive value. The spring 2016 survey (123 units) and summer 2017 survey (127 units) scores were both not significantly different from the distance predictive value.

The median value for ringplain streams of similar altitude (TRC, 2016b) was 113 units. The spring and historical median scores were significantly higher than the median value but there was no significant difference for the summer survey. The REC predicted MCI value (Leathwick, et al. 2009) was 121 units. The historical site median, spring and summer scores were not significantly different from this value.

3.2.16.1.4 Temporal trends 1995 to 2017

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 99). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Punehu Stream at Wiremu Road.



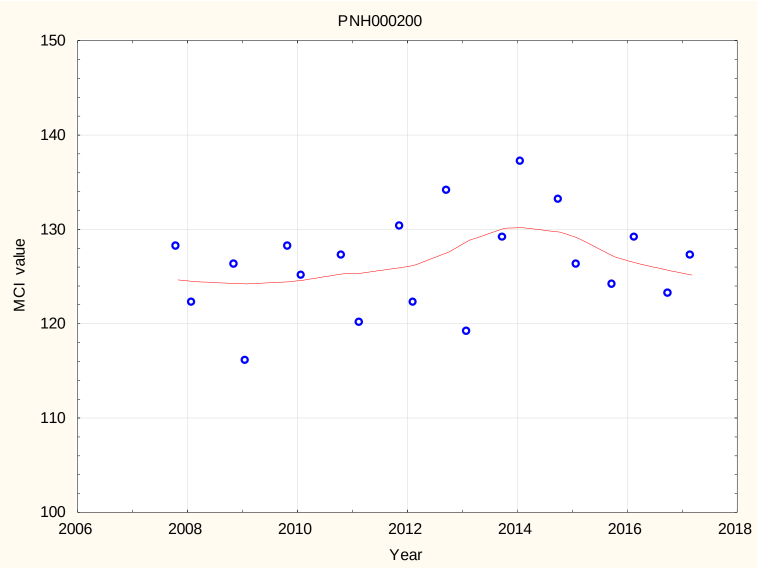
N = 44
Kendall tau = +0.323
p level = 0.002
FDR p = 0.004

Figure 99 LOWESS trend plot of MCI data at the Wiremu Road site, Punehu Stream

A steady increase in MCI scores had been apparent between 2002 and 2007, and again since 2010, resulting in the positive trend in scores over the entire period which has been statistically significant (FDR p<0.01 level). The trendline range (15 units) has been of ecological importance, particularly since 2002 (coincident with localised riparian fencing and planting of the true left-bank of the stream). Overall, the trendline range was indicative of 'very good' generic stream health (Table 2) apart from a short period of 'good' health from 1997 to 2005.

3.2.16.1.5 Temporal trends 2007 to 2017

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 100). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Punehu Stream at Wiremu Road.



N = 20
Kendall tau = +0.133
p level = 0.411
FDR p = 0.645

Figure 100 LOWESS trend plot of ten years MCI data at the Wiremu Road site, Punehu Stream

A positive, non-significant trend was found which contrasts with the highly significant, positive trend found in the full dataset. A small but steady increase in MCI scores had occurred between 2009 and 2014 but a subsequent decline resulted in no overall significant trend. Overall, the trendline range of scores were indicative of 'very good' generic stream health (Table 2).

3.2.16.2 SH 45 site (PNH000900)

3.2.16.2.1 Taxa richness and MCI

Forty surveys have been undertaken at this lower reach site at SH 45 in the Punehu Stream between October 1995 and February 2015. These results are summarised in Table 52, together with the results from the current period, and illustrated in Figure 101.

Table 72 Results of previous surveys performed in the Punehu Stream at SH 45 together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000900	42	10-26	21	70-106	89	20	96	24	87

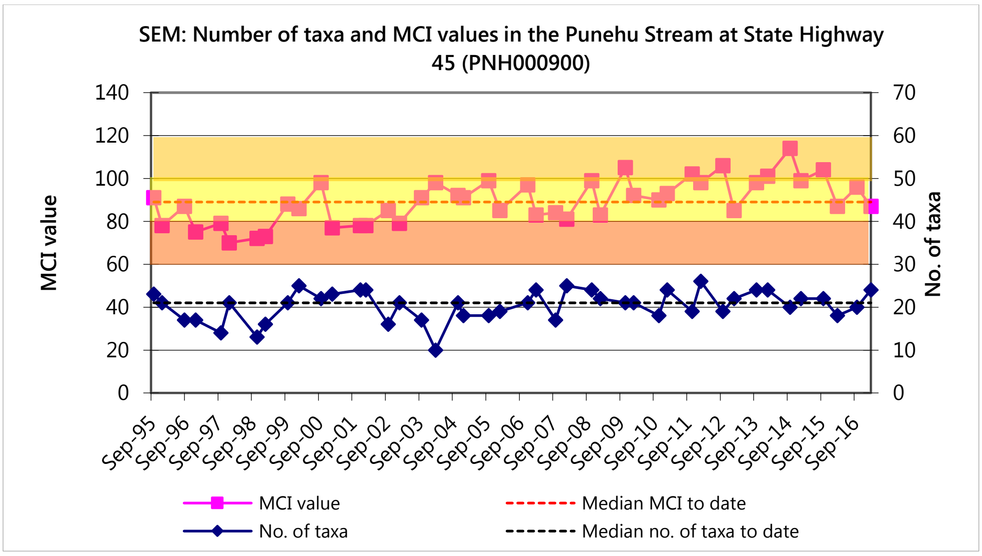


Figure 101 Numbers of taxa and MCI values in the Punehu Stream at SH 45

A wide of richnesses (10 to 26 taxa) has been found with a median richness of 21 taxa, relatively typical of richnesses in the lower reaches of ringplain streams and rivers. During the 2016-2017 period, spring (20 taxa) and summer (24 taxa) richnesses were moderate and similar to the historic median.

MCI scores have had a relatively wide range (36 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (89 units) also has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (96 units) and summer 2017 (87 units) scores were not significantly different to the historical median. These scores categorised this site as having 'fair' (spring and summer) health generically (Table 2). The historical median score (89 units) placed this site in the 'fair' category for generic health.

3.2.16.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 53.

Table 73 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Punehu Stream at SH 45 between 1995 and March 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	19	8	4	31	74	A	VA
MOLLUSCA	*Potamopyrgus*	4	17	5		22	52		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	5			5	12		A
	Coloburiscus	7	6	2		8	19		A
	Deleatidium	8	3	6	10	19	45		VA
PLECOPTERA (STONEFLIES)	*Acroperla*	5	1			1	2		
	Zelandobius	5	1			1	2		
COLEOPTERA (BEETLES)	Elmidae	6	11	7	8	26	62		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	10			10	24		

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	12	6	4	22	52		VA
	Hydrobiosis	5	15	1		16	38		A
	Beraeoptera	8	2			2	5		
	Oxyethira	2	4			4	10		
	Pycnocentrodes	5	5	11	3	19	45		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	15	4		19	45		A
	Maoridiamesa	3	11	7		18	43		A
	Orthocladiinae	2	22	6	7	35	83	A	VA
	Polypedilum	3	1	1		2	5		A
	Tanytarsini	3	9	2		11	26		A
	Ceratopogonidae	3	1			1	2		
	Empididae	3	6			6	14		
	Muscidae	3	2			2	5		
	Austrosimulium	3	6			6	14		A

Prior to the current 2016-2017 period 21 taxa have characterised the community at this site on occasions. These have comprised two 'highly sensitive', nine 'moderately sensitive', and eleven 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa as might be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly sensitive' taxa; one 'moderately sensitive' taxon [elmid beetles], and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges].

The spring community had two characteristic taxa which comprised tolerant taxa which was reflected in the low $SQMCI_s$ score of 3.3 units indicating 'poor' health. The summer community had 12 characteristic taxa which comprised a mixture of sensitive and tolerant taxa which was reflected in the $SQMCI_s$ score of 4.0 units indicating 'fair' health (Table 71) (Table 150 and Table 151).

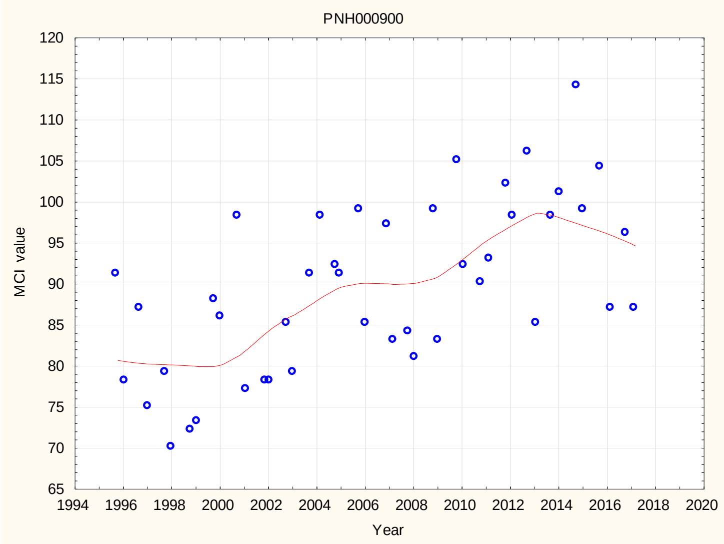
3.2.16.2.3 Predicted stream 'health'

The Punehu Stream site at SH 45 is 20.9 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 98 for this site. The historical site median (89 units) was a non-significant (Stark, 1998) nine units lower than the distance predictive value. The spring 2016 survey (96 units) and summer 2017 (87 units) scores were not significantly different to the distance predictive value.

The median value for ringplain streams of similar altitude (TRC, 2016b) was 90 units. The historical median, spring and summer scores were not significantly difference the median value for similar sites. The REC predicted MCI value (Leathwick, et al. 2009) was 100 units. The historical site median and summer scores were significantly lower than this value but there was no significant difference for the spring survey.

3.2.16.2.4 Temporal trends in 1995 to 2017

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 102). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Punehu Stream at SH 45.



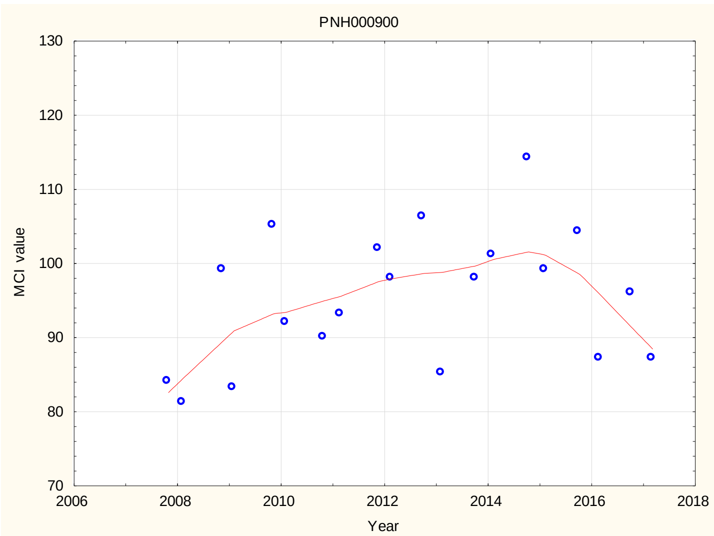
N = 44
Kendall tau = +0.445
p level < 0.001
FDR p < 0.001

Figure 102 LOWESS trend plot of MCI data at the SH 45 site, Punehu Stream

This site's MCI scores have shown a strong positive temporal trend over the 22 year period which was statistically significant ($p<0.01$) after FDR application.The trendline range of scores (20 units) has been ecologically important over this period with scores mainly indicative of 'poor' generic stream health (Table 2) prior to early 1999 improving to 'fair' health throughout most of the subsequent period and to 'good' health more recently.

3.2.16.2.5 Temporal trends in 2007 to 2017

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 102).A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Punehu Stream at SH 45.



N = 20
Kendall tau = +0.207
p level = 0.202
FDR p = 0.492

Figure 103 LOWESS trend plot of ten years of MCI data at the SH 45 site, Punehu Stream

A positive, non-significant trend was found which contrasts with the highly significant, positive trend found in the full dataset. A steady increase in MCI scores had occurred between 2006 and 2015 but a subsequent decline resulted in no overall significant trend. Overall, the trendline was indicative of 'good' generic stream health (Table 2).

3.2.16.3 Discussion

The Punehu Stream at the SEM sites was found to have moderate taxa richnesses which was consistent with the results from past surveys.

The upper mid-reach (Wiremu Road) site had 'very good' macroinvertebrate community health while the lower reach(SH 45) site had 'fair' macroinvertebrate community health. MCI scores were largely congruent with $SQMCI_s$ scores though the $SQMCI_s$ score showed a significant decrease in condition at the upper site from spring to summer while the MCI score did not.

MCI scores typically significantly fell in a downstream direction in both spring (by 27 units) and in summer (by 40 units), over a stream distance of 16.5 km through the (upper) mid to lower reaches of this stream. Issues have occurred on occasions with consented dairy shed discharge compliance and cumulative impacts of such discharges in the Mangatawa Stream sub-catchment in the local vicinity of the lower site (TRC, 2011 and Fowles, 2014). Changes in macroinvertebrate community structure at the lower site, especially when compared with the upper mid-reach site, reflect ongoing issues with nutrient enrichment.

The time trend analysis showed significant positive trends for both sites for the full dataset indicating that over time macroinvertebrate community health has been significantly improving at both sites. The ten year trend for both sites was positive but non-significant suggesting that macroinvertebrate health was not significantly improving over the more recent time period or not at a level that was great enough to be statistically significant.

3.2.17 Tangahoe River

The Tangahoe River is an eastern hill country river flowing north to south with a river mouth located east of Hawera. Three sites were included in the SEM programme in 2007 for the purpose of monitoring long-term land use changes (afforestation) particularly in the upper-mid catchment. The Fonterra, Hawera dairy factory abstracts water from the river in the lower catchment for processing purposes. Two of the three sites are in the upper to mid, shallow gradient, reaches of the river (the upstream site within 4 km of the headwaters) with the third site in the lower reaches, some 4 km from the coast.

The results of the 2016–2017 spring and summer surveys are presented in Table 152 and Table 153, Appendix I.

3.2.17.1 Upper Tangahoe Valley Road site (TNH000090)

3.2.17.1.1 Taxa richness and MCI

Eighteen surveys have been undertaken at this upper reach site in the Tangahoe River between December 2007 and March 2016. These results are summarised in Table 74, together with the results from the current period, and illustrated in Figure 104.

Table 74 Results of previous surveys performed in the Tangahoe River at upper Tangahoe Valley Road, together with spring 2016 and summer 2017 results

Site code	SEM data (2007 to March 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000090	18	14-31	24	90-107	100	17	98	25	106

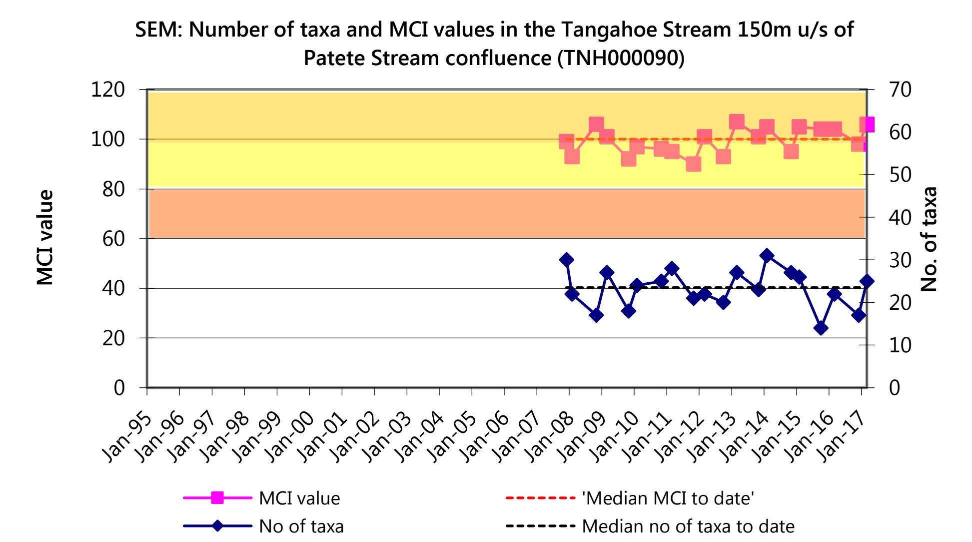


Figure 104 Numbers of taxa and MCI values in the Tangahoe River at Upper Tangahoe Valley Road

A relatively wide range of richnesses (14 to 31 taxa) has been found with a moderate median richness of 24 taxa (lower than richnesses which might be anticipated toward the upper reaches of hill country rivers) but higher than the median richness (20 taxa) for sites at this relatively low altitude (85 m asl) (TRC, 2016b). During the 2016-2017 period, spring (17 taxa) taxa richness was lower than the historic median. Summer (25 taxa) richness was very similar to the median richness of 24 taxa.

MCI values have had a relatively narrow range (17 units) at this site, typical of scores at sites toward the upper reaches of streams and rivers. The spring 2016 (98 units) and summer 2017 (106 units) scores were not significantly different to the historic median score. These scores categorised this site as having 'fair' health (spring) and 'good' health (summer) generically (Table 2). The historical median score (98 units) placed this site in the 'fair' category for the generic method of assessment.

3.2.17.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 75.

Table 75 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Tangahoe River at upper Tangahoe Valley Road between 2007 and March 2016 [18 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	8			8	44		
MOLLUSCA	*Potamopyrgus*	4	2	7	6	15	83	A	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	12	5		17	94	XA	VA
	Deleatidium	8	4	5	7	16	89	XA	VA
	Zephlebia group	7	6	3		9	50	A	
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	3			3	17		
COLEOPTERA (BEETLES)	Elmidae	6	6	9	1	16	89	A	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	3			3	17		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	3			3	17		
	Hydrobiosis	5	3			3	17		
DIPTERA (TRUE FLIES)	Orthocladiinae	2	3			3	17		
	Austrosimulium	3	8	4	1	13	72	A	VA

Prior to the current 2016-2017 period, 12 taxa have characterised the community at this site on occasions. These have comprised two ‘highly sensitive’, five ‘moderately sensitive’, and five ‘tolerant’ taxa i.e. a higher proportion of ‘tolerant’ taxa than would be expected toward the upper reaches of hill-country river, reflecting the relatively flat gradient of this river to this site. Predominant taxa have included one ‘highly sensitive’ taxon (mayfly (*Deleatidium*)); two ‘moderately sensitive’ taxa [mayfly (*Austroclima*) and elmid beetles]; and three ‘tolerant’ taxa [snail (*Potamopyrgus*), oligochaete worms, and sandfly (*Austrosimulium*)].

The spring 2016 community consisted of six characteristic taxa which were mostly sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.2 units indicating ‘excellent’ health. The summer 2017 community consisted of five characteristic taxa which were a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 5.5 units indicating ‘good’ health (Table 75) (Table 152 and Table 153).

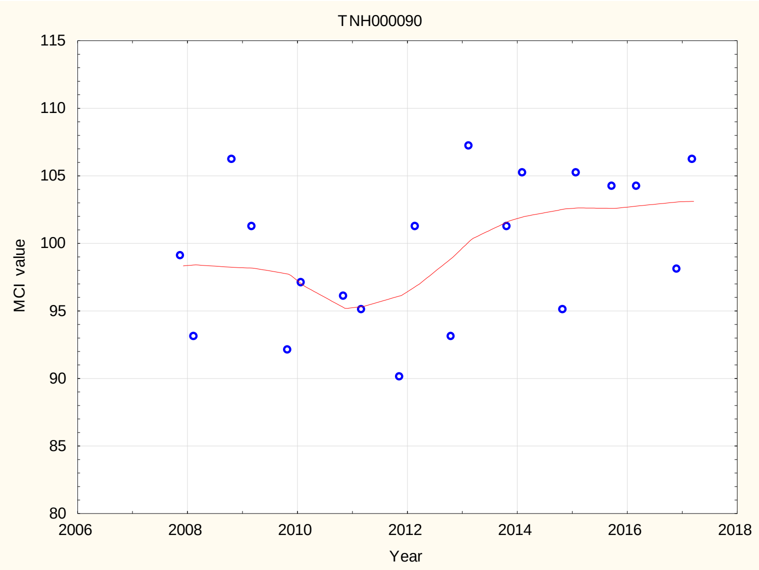
3.2.17.1.3 Predicted stream ‘health’

The Tangahoe River site at upper Tangahoe Valley Road, at an altitude of 85 m asl, is toward the upper reaches of this low gradient river draining an eastern hill country catchment.

The median value for an eastern hill country streams (TRC, 2016b) at a similar altitude was 93 units. The historic median and spring scores were not significantly different to this value and the summer score was significantly higher by 15 units. The REC predicted MCI value (Leathwick, et al. 2009) was 110 units and therefore the historic median and summer scores were not significantly different but the spring score was significantly lower.

3.2.17.1.4 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 105). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the SEM results (2007-2017) from the site in the Tangahoe River at upper Tangahoe Valley Road.



N = 20
Kendall tau = +0.247
p level = 0.127
FDR p = 0.207

Figure 105 LOWESS trend plot of MCI data in the Tangahoe River for the upper Tangahoe Valley site

There was a small, positive, but non-significant trend for this hill country catchment site toward the upper reaches. The trendline range (eight units) was of limited ecological importance to date. The trendline range indicated 'fair' health from 2007-2013 before improving to 'good' health (Table 2) for the last four years (Figure 104).

3.2.17.2 Tangahoe Valley Road bridge site (TNH000200)

3.2.17.2.1 Taxa richness and MCI

Eighteen surveys have been undertaken at this mid reach site in the Tangahoe River between December 2007 and March 2016. These results are summarised in Table 76, together with the results from the current period, and illustrated in Figure 106.

Table 76 Results of previous surveys performed in the Tangahoe River at Tangahoe Valley Road bridge, together with spring 2016 and summer 2017 results

Site code	SEM data (2007 to March 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000200	18	20-33	25	92-108	103	17	100	27	110

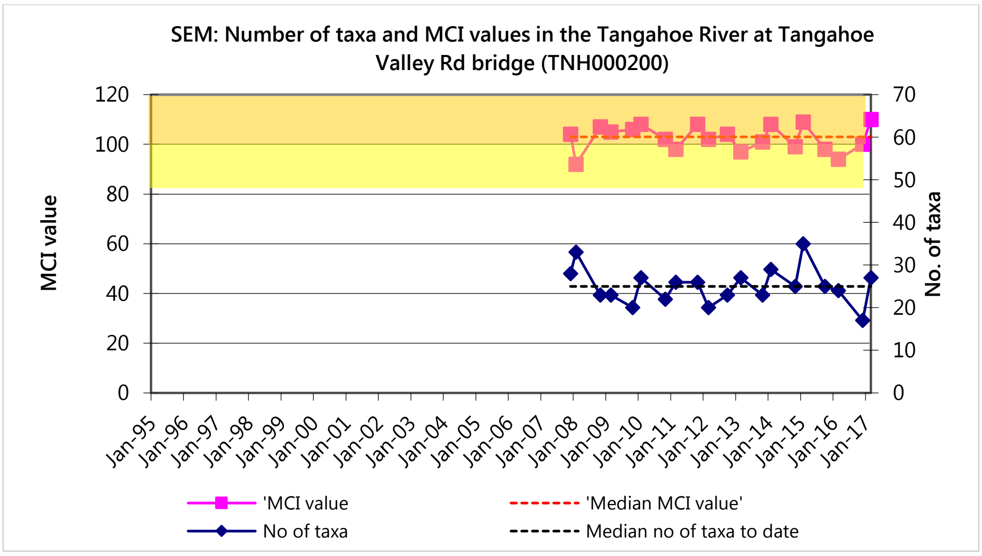


Figure 106 Numbers of taxa and MCI values in the Tangahoe River at Tangahoe Valley Road bridge

A moderate range of richnesses (20 to 33 taxa) has been found with a relatively good median richness of 25 taxa (typical of richnesses in the mid-reaches of hill country rivers). During the 2016-2017 period, spring richness (17 taxa) was significantly lower than the historic median (25 taxa) and the lowest taxa richness recorded at the site to date, while summer richness (27 taxa) was very similar to the historic median.

MCI values have had a moderate range (16 units) at this site, typical of a site in the mid-reaches of hill country streams and rivers. The spring 2016 (100 units) and summer 2017 (110 units) scores were not significantly different to the historic median (103 units). These scores categorised this site as having 'good' health generically (Table 2). The historical median score (103 units) placed this site in the 'good' category for the generic assessment of health.

3.2.17.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 77.

Table 77 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Tangahoe River at Tangahoe Valley Road bridge between 2007 and March 2016 [18 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	2	1		3	17		
MOLLUSCA	*Potamopyrgus*	4	6	3	1	10	56	A	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	5	11	1	17	94	XA	VA
	Coloburiscus	7	5	1		6	33		
	Deleatidium	8	4	11		15	83	XA	VA
	Rallidens	9	1			1	6		
	Zephlebia group	7	8	3		11	61	A	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	3			3	17		
	Zelandobius	5	6	1		7	39		

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
COLEOPTERA (BEETLES)	Elmidae	6	5	12	1	18	100	A	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	4			4	22		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	7	6	1	14	78		A
	Hydrobiosis	5	6			6	33		
	Oxyethira	2	1	1		2	11		
	Pycnocentrodes	5	1			1	6		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	7	2		9	50		
	Orthocladiinae	2	8	1		9	50		
	Tanytarsini	3	5	2		7	39		A
	Austrosimulium	3	4	1		5	28	A	

Prior to the current 2016-2017 period, 19 taxa have characterised the community at this site on occasions. These have comprised two 'highly sensitive', ten 'moderately sensitive', and seven 'tolerant' taxa i.e. a relatively high proportion of 'sensitive' taxa as would be expected in the mid-reaches of a hill-country river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [mayflies (*Austroclima* and *Zephlebia* group), elmid beetles, and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges].

The spring 2016 community consisted of six characteristic taxa which were a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 5.9 units indicating 'good' health. The summer 2017 community consisted of seven characteristic taxa which were also a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 5.9 units indicating 'good' health. The historical median score (103 units) placed this site in the 'good' category for the generic assessment of health. (Table 77) (Tables 172 and 173).

3.2.17.2.3 Predicted stream 'health'

The Tangahoe River site at Tangahoe Valley Road bridge, at an altitude of 65 m asl, is in the mid reaches of a river draining a hill country catchment.

The median value for an eastern hill country streams (TRC, 2016b) at a similar altitude was 102 units. The historic median, spring and summer scores were all not significantly different to this predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 108 units. The historic, spring and summer scores were not significantly different to this predictive value either (Stark, 1998).

3.2.17.2.4 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 107). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the SEM results (2007-2017) from the site in the Tangahoe River at the Tangahoe Valley Road bridge.

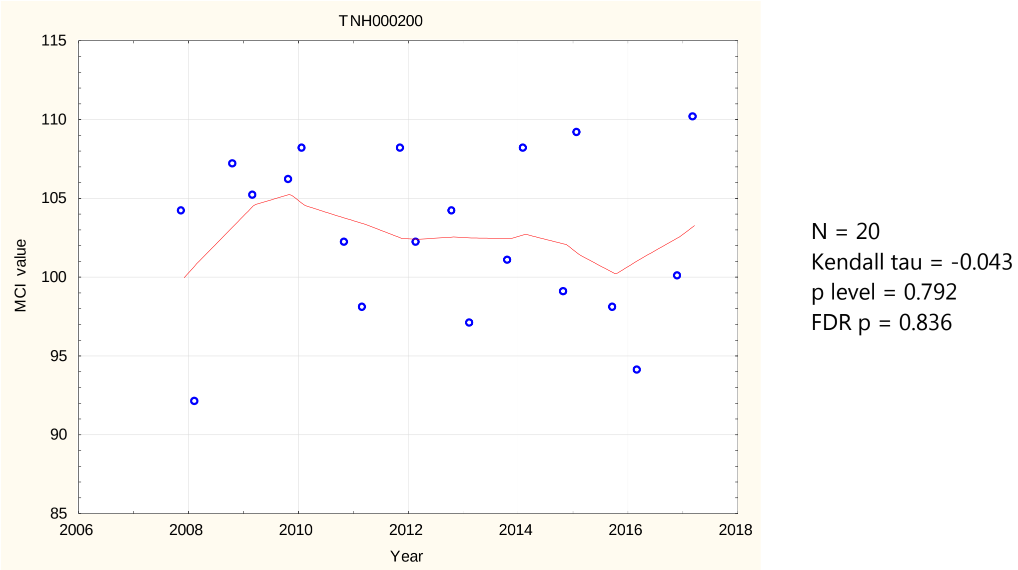


Figure 107 LOWESS trend plot of MCI data in the Tangahoe River for the Tangahoe Valley Road bridge site

There was a small, negative, non-significant trend for this mid river reach, hill country catchment site. The trendline range (seven units) over the period has been of limited ecological importance. The trendline range has indicated 'good' generic river health (Table 2).

3.2.17.3 Site downstream of railbridge (TNH000515)

3.2.17.3.1 Taxa richness and MCI

Eighteen surveys have been undertaken at this lower reach site in the Tangahoe River between August 1997 and March 2016 with eighteen of these surveys since 2007. These results are summarised in Table 78, together with the results from the current period, and illustrated in Figure 108.

Table 78 Results of previous surveys performed in the Tangahoe River d/s of railbridge, together with spring 2016 and summer 2017 results

Site code	SEM data (1997 to March 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Mar 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000515	18	13-26	20	78-104	94	20	95	20	89

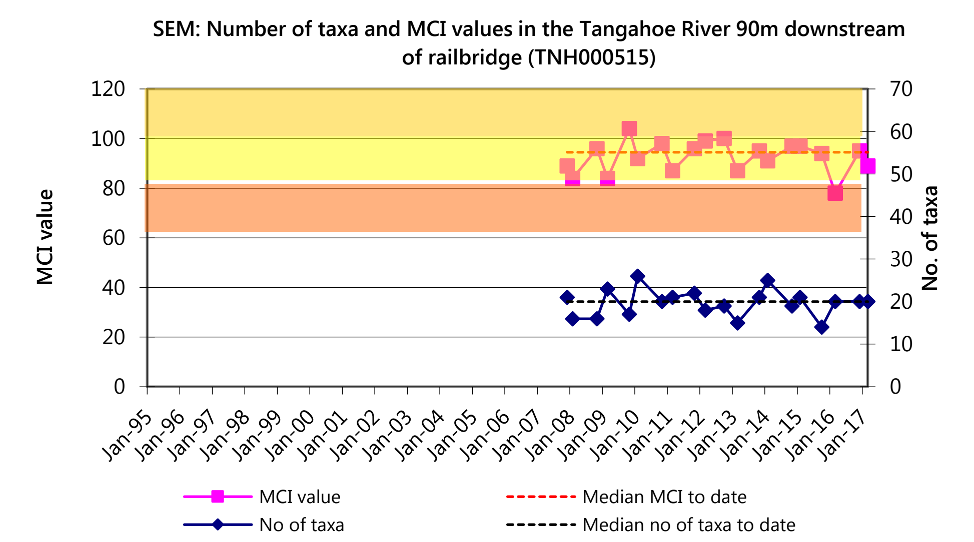


Figure 108 Numbers of taxa and MCI values in the Tangahoe River downstream of the railbridge

A moderate range of richnesses (13 to 26 taxa) have been found with a slightly higher than typical median richness of 20 taxa for a site in the lower reaches of a hill country river (TRC, 2016b). During the 2016-2017 period, spring (20 taxa) and summer (20 taxa) richnesses were the same as the median richness.

MCI values also have had a moderate range (26 units) at this site, narrower than typical of sites in the lower reaches of hill country streams and rivers. The spring 2016 (95 units) and summer 2017 (89 units) scores were very similar to the historical median. These scores categorised this site as having 'fair' health generically (Table 2). The historical median score (94 units) placed this site in the 'fair' category for the generic method of assessment.

3.2.17.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 79.

Table 79 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Tangahoe River d/s of the railbridge between 1995 and March 2016 [18 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	1			1	6		
ANNELIDA (WORMS)	Oligochaeta	1	11	2	1	14	78	A	
MOLLUSCA	*Latia*	5	3			3	17		
	Potamopyrgus	4	4	4	1	9	50	A	VA
CRUSTACEA	*Paracalliope*	5	1			1	6		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	3			3	17	A	
	Deleatidium	8	3			3	17	A	
	Zephlebia group	7	1			1	6		
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	1			1	6		
COLEOPTERA (BEETLES)	Elmidae	6	6	9	3	18	100	VA	VA

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	4	5	8	17	94	VA	XA
	Hydrobiosis	5	1			1	6		A
	Pycnocentrodes	5	4	3	2	9	50	VA	XA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	6			6	33	A	A
	Maoridiamesa	3	4	1		5	28	VA	A
	Orthocladiinae	2	7	6	2	15	83		A
	Polypedilum	3	2			2	11		
	Tanytarsini	3	2			2	11		A
	Austrosimulium	3	2	1		3	17		

Prior to the current 2016-2017 period, a moderate number of taxa (19) have characterised the community at this site on occasions due in part to the short duration of monitoring at this site. These have comprised one 'highly sensitive', nine 'moderately sensitive', and nine 'tolerant' taxa i.e. a relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a hill-country river. Predominant taxa have included one 'moderately sensitive' taxon [elmid beetles] and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges].

The spring 2016 community consisted of nine characteristic taxa which were a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 4.6 units indicating 'fair' health. The summer 2017 community consisted of nine characteristic taxa which were also a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 4.9 units indicating 'fair' health. The historical median score (94 units) placed this site in the 'fair' category (Table 79, Tables 172 and 173).

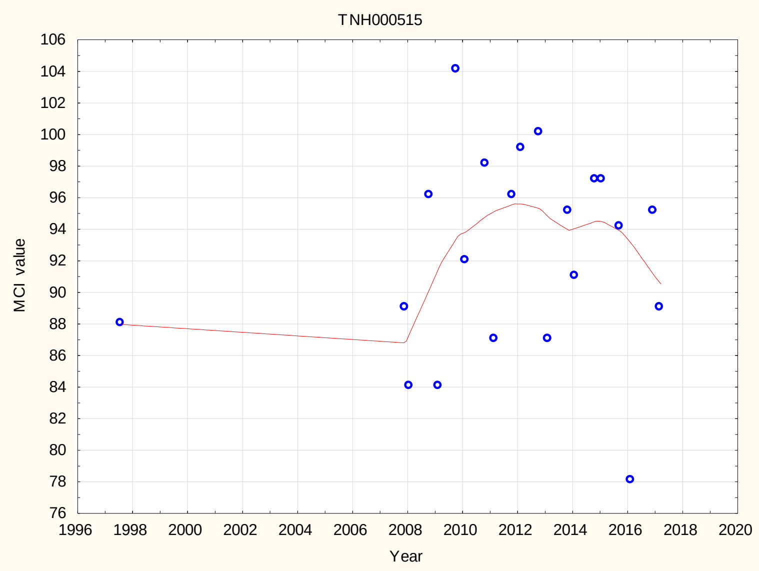
3.2.17.3.3 Predicted stream 'health'

The Tangahoe River site downstream of the railbridge, at an altitude of 15 m asl, is in the lower reaches of a river draining a hill country catchment.

The median value for an eastern hill country streams (TRC, 2016b) at a similar altitude was 78 units. The historic, spring and summer scores were significantly higher than this value. The REC predicted MCI value (Leathwick, et al. 2009) was 95 units and therefore the historic, spring and summer scores were not significantly different (Stark, 1998).

3.2.17.3.4 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 109). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the SEM results (2007-2017) from the site in the Tangahoe River downstream of the railbridge.



N = 20
Kendall tau = +0.048
p level = 0.759
FDR p = 0.832

Figure 109 LOWESS trend plot of MCI data for the Tangahoe River site downstream of the railbridge

There was a non-significant positive trend for this lower river reach, hill country catchment site. The trendline range (10 units) has bordered on ecologically important but overall there has been no real change over the monitored period. The trendline range have indicated ‘fair’ generic river health (Table 2) over the period to date (Figure 109).

3.2.17.4 Discussion

The Tangahoe River at the SEM sites was found to have moderate to moderately low taxa richnesses which was consistent with the results from past surveys.

The upper reach (upper Tangahoe Valley Road) site had ‘fair’ macroinvertebrate community health during spring but the $SQMCI_s$ score indicated ‘excellent’ health, largely due to the high numbers of sensitive mayflies present at the site and was probably a better reflection of true macroinvertebrate community health. The MCI and $SQMCI_s$ scores for the summer survey were congruent indicating ‘good’ macroinvertebrate health. The middle site at the Tangahoe Valley Road Bridge had ‘good’ macroinvertebrate community health for both spring and summer while the lower reach site at the railbridge had ‘fair’ macroinvertebrate community health.

MCI scores fell in a downstream direction in both spring (by three units) and in summer (by 17 units), over a distance of 30.2 km (and decrease in elevation of 70 m) though MCI scores actually improved from the upper to middle sites. The improvement in macroinvertebrate health would be related to better quality habitat present at the middle site which has a riffle with a cobbles/ boulder substrate as opposed to the upper site with a clay dirt substrate. Using the long-term median SEM MCI scores for each site (Appendix II), there is normally an improvement in MCI scores between the upper reach (Upper Tangahoe Valley Road) and the mid-reach (Tangahoe Valley Road bridge) sites by six units. The decline between the mid-reach site and lower reach (railbridge) site has historically been nine units.

The time trend analyses showed no significant trends for any site indicating that macroinvertebrate health was not significantly improving or deteriorating.

3.2.18 Timaru Stream

Timaru Stream is a ringplain stream arising within Egmont National Park and flows from east to west. There are two SEM sites situated on the stream. In the 2008-2009 period severe headwater erosion events had impacted upon the macroinvertebrate communities of the upper reaches of this stream in particular (TRC, 2009). Due to persistently high flows no spring 2016 survey was able to be performed. The results for the summer 2017 survey are presented in Table 154, Appendix I.

3.2.18.1 Carrington Road site (TMR000150)

3.2.18.1.1 Taxa richness and MCI

Forty-two surveys have been undertaken at this upper reach site in the Timaru Stream inside the National Park boundary at Carrington Road between October 1995 and February 2016. These results are summarised in Table 80, together with the result from the current period, and illustrated in Figure 110.

Table 80 Results of previous surveys performed in the Timaru Stream at Carrington Road, together with spring 2015 and summer 2016 results

Site code	SEM data (1995 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
TMR000150	42	8-33	26	119-146	138	22	152

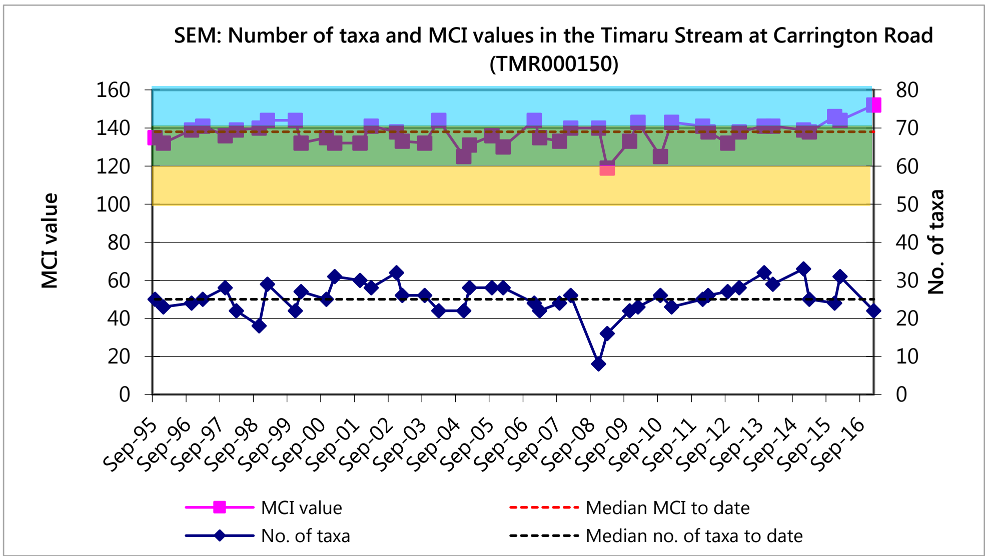


Figure 110 Numbers of taxa and MCI values in the Timaru Stream at Carrington Road

Taxa richness was typically moderately high for the site (median richness of 26 taxa) with only one low result in December 2008 (eight taxa) due to headwater erosion effects over the 2008-2009 period which markedly reduced richness. The median richness was similar to the typical richness (28 taxa) in ringplain streams and rivers near the National Park boundary over 400 m in altitude (TRC, 2016b). During the 2016-2017 period, summer (22 taxa) richness was slightly lower than the median and typical ringplain stream richnesses, possibly due to the persistently high spring flows.

MCI values have had a wider range (27 units) at this site than typical of a site near the National Park boundary due to the low value (119 units) after the 2008-2009 headwater erosion period. However, the median value (138 units) is slightly higher than typical upper reach sites elsewhere on the ringplain (134 units). The summer 2017 score (152 units) was significantly higher the historical median, the highest score ever recorded for the site and was the highest recorded score for any SEM site in the reported period. The score categorised this site as having 'excellent' health generically (Table 2). The historical median score (138 units) placed this site in the 'very good' category for the generic health.

3.2.18.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 81.

Table 81 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Timaru Stream at Carrington Road between 1995 and February 2016 [42 surveys], and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	1			1	2	
	Austroclima	7	4			4	10	
	Coloburiscus	7	24	9		33	79	A
	Deleatidium	8	8	11	23	42	100	VA
	Nesameletus	9	33	4		37	88	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	4			4	10	
	Megaleptoperla	9	1			1	2	
	Stenoperla	10	2			2	5	
	Zelandobius	5	24	5		29	69	
	Zelandoperla	8	17	11	1	29	69	VA
COLEOPTERA (BEETLES)	Elmidae	6	19			19	45	
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	3			3	7	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	1			1	2	
	Costachorema	7	2			2	5	
	Hydrobiosis	5	1			1	2	
	Hydrobiosella	9	3			3	7	
	Hydropsyche (Orthopsyche)	9	2			2	5	
	Beraeoptera	8	6			6	14	
	Helicopsyche	10	6			6	14	
	Olinga	9	2			2	5	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	15			15	36	
	Maoridiamesa	3	3		1	4	10	
	Orthocladiinae	2	18	5		23	55	

Prior to the 2016-2017 period, 22 taxa had characterised the community at this site. These have comprised eleven 'highly sensitive', nine 'moderately sensitive', and three 'tolerant' taxa i.e. the majority of taxa were classified as 'sensitive' taxa as would be expected near the National Park boundary of a ringplain stream. Taxa that have occurred over 50% of the time included three 'highly sensitive' taxa [mayflies (*Deleatidium* (on every sampling occasion), and *Nesameletus*) and stonefly (*Zelandoperla*)]; two 'moderately sensitive' taxa [mayfly (*Coloburiscus*) and stonefly (*Zelandobius*)], and one 'tolerant' taxon (orthoclad midges). Four taxa were dominant in the summer 2017 survey.

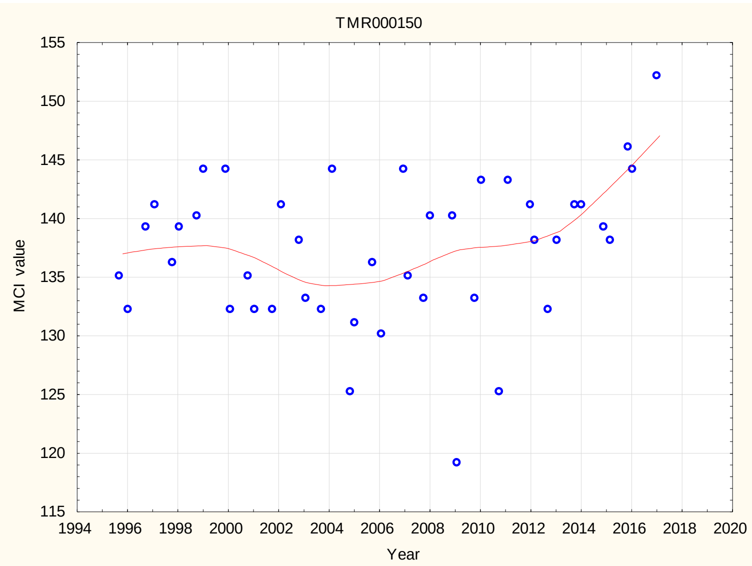
3.2.18.1.3 Predicted stream 'health'

The Timaru Stream at Carrington Road is within the National Park boundary at an altitude of 420 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median (138 units) was not significantly different to the predictive value but the summer 2017 score (152 units) was significantly higher (Stark, 1998).

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 134 units. The historical site median was not significantly different to this value but the summer score was significantly higher. The REC predicted MCI value (Leathwick, et al. 2009) was 141 units. The historical site median was not significantly different to this value but the summer score was significantly higher.

3.2.18.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 111). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on 22 years of SEM results (1995-2017) from the site in the Timaru Stream at Carrington Road.



N = 43
Kendall tau = +0.154
p level = 0.145
FDR p = 0.228

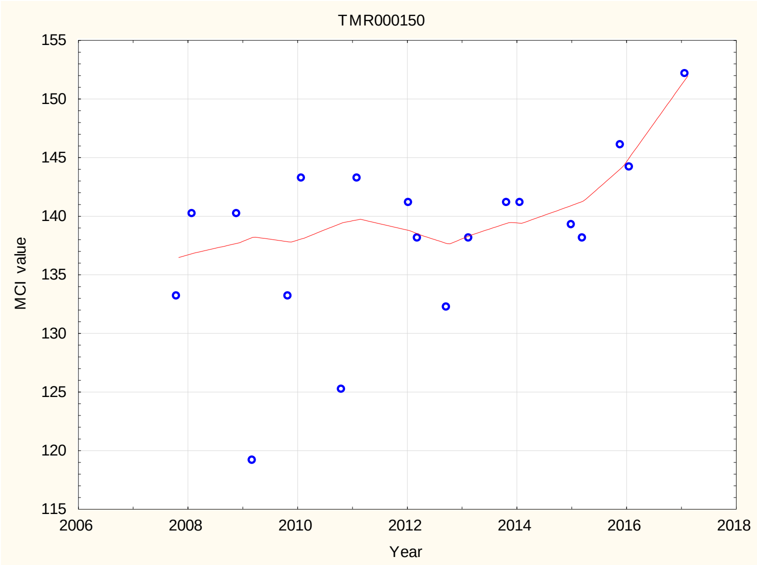
Figure 111 LOWESS trend plot of MCI data at the Carrington Road site

There was a small, positive, non-significant trend. The trendline had a range over nine units which was not ecologically important. The trendline scores have been indicative of 'very good' generic stream health from 1995 to 2014, increasing to 'excellent' health since 2014 (Table 2).

3.2.18.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced in Figure 112.

A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the most recent ten years of SEM results (2007-2017) from the site in the Timaru Stream at Carrington Road.



N = 19
Kendall tau = +0.372
p level = 0.026
FDR p = 0.287

Figure 112 LOWESS trend plot of ten years of MCI data at the Carrington Road site

MCI scores have trended very slightly upwards in general but the trend has not been statistically significant over the period. The LOWESS-smoothed MCI scores have ranged over seven units which has not been ecologically important. Smoothed scores have been indicative of 'very good' generic stream health (Table 2) to 'excellent' health since 2014.

3.2.18.2 SH45 site (TMR000375)

3.2.18.2.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Timaru Stream at this lower, mid-reach site at SH45 between October 1995 and February 2016. These results are summarised in Table 82, together with the results from the current period, and illustrated in Figure 113.

Table 82 Results of previous surveys performed in the Timaru Stream at SH45, together with summer 2017 result

Site code	SEM data (1995 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
TMR000375	42	13-35	27	89-120	103	26	110

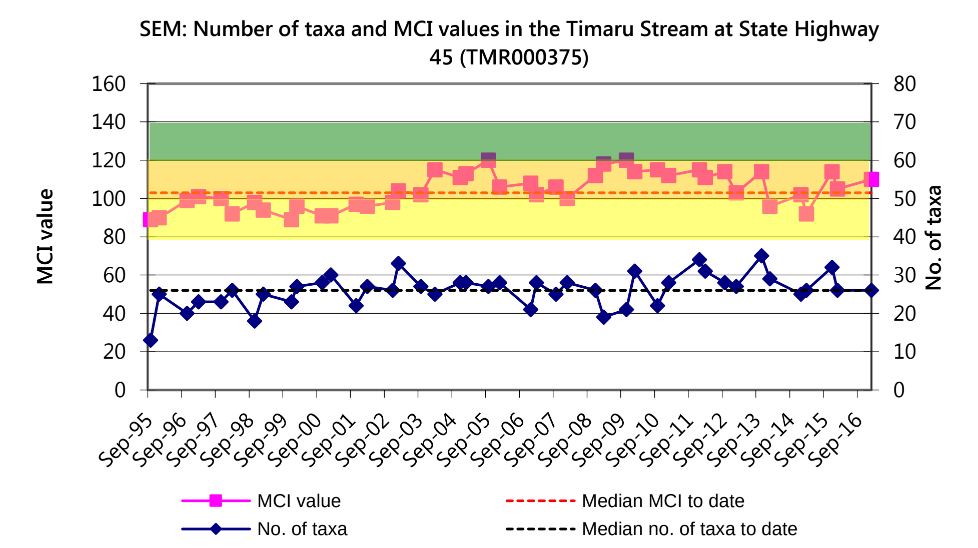


Figure 113 Numbers of taxa and MCI values in the Timaru Stream at State Highway 45

An unusually wide range of richnesses (13 to 35 taxa) has been found with a median richness of 27 taxa (higher than typical richnesses in the mid reaches of ringplain streams and rivers (TRC, 2016b)). During the 2016-2017 period summer (26 taxa) richness was one taxon lower than the historical median taxa number.

MCI values have had a slightly wider range (31 units) at this site than typical of sites in the mid reaches of ringplain streams. The median value (103 units) was very similar to the median calculated from mid reach sites on the ringplain. The summer 2017 score was not significantly different (Stark, 1998) to the historical median. The score categorised this site as having 'good' health generically (Table 2). The historical median score (103 units) placed this site in the 'good' category for the generic health.

3.2.18.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 83.

Table 83 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Timaru Stream at SH45 between 1995 and February 2016 [42 surveys], and summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
NEMERTEA	Nemertea	3	1			1	2	
ANNELIDA (WORMS)	Oligochaeta	1	7	4	2	13	31	
MOLLUSCA	*Potamopyrgus*	4	7			7	17	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	12	4		16	38	A
	Coloburiscus	7	14	11	1	26	62	A
	Deleatidium	8	11	3	4	18	43	A
	Rallidens	9	2			2	5	
PLECOPTERA (STONEFLIES)	*Acroperla*	5	3	2		5	12	
	Zelandobius	5	1	2		3	7	
	Zelandoperla	8	14	2	1	17	40	

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
COLEOPTERA (BEETLES)	Elmidae	6	17	7		24	57	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	19	3		22	52	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	17	19	3	39	93	A
	Costachorema	7	11	1		12	29	
	Hydrobiosis	5	10			10	24	
	Neurochorema	6	9			9	21	A
	Beraeoptera	8	1	5	1	7	17	
	Confluens	5	1			1	2	
	Oxyethira	2	6	2		8	19	
	Pycnocentrodes	5	11	8	2	21	50	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	18	20	1	39	93	VA
	Maoridiamesa	3	24	6	2	32	76	A
	Orthocladiinae	2	23	11	4	38	90	A
	Tanytarsini	3	11	1		12	29	
	Empididae	3	5			5	12	
	Muscidae	3	5			5	12	
	Austrosimulium	3	15			15	36	

Prior to the current 2016-2017 period, relatively large number (27) of taxa had characterised the community at this site on occasions. These have comprised four 'highly sensitive', twelve 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increase in the proportion of 'tolerant' taxa as would be expected in the mid reaches compared with the upper reaches of a ringplain stream. Characteristic taxa that occurred over 50% of the time included three 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, and cranefly (*Aphrophila*)], and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)]. Twelve of the historically characteristic taxa were dominant in the summer 2017 community (Table 83).

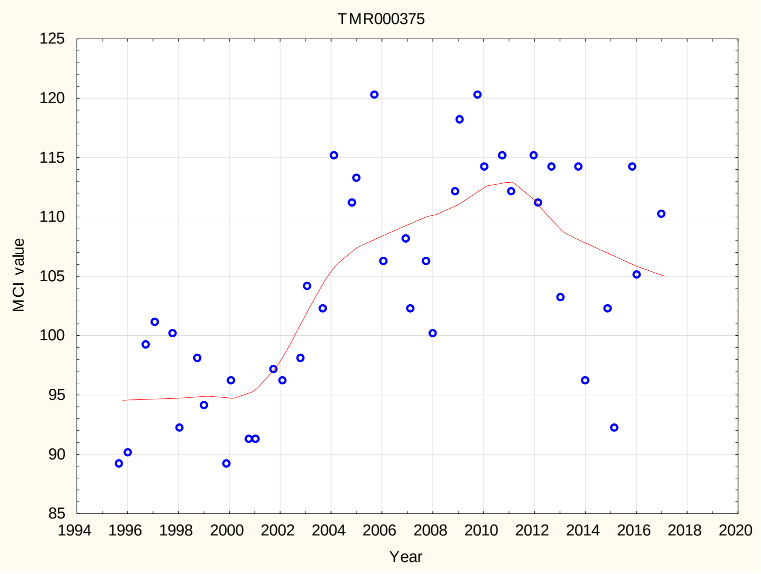
3.2.18.2.3 Predicted stream 'health'

The Timaru Stream at SH45 is 10.9 km downstream of the National Park boundary at an altitude of 100 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 105 for this site. The historical site median (103) was not significantly different to the predictive value. The summer survey score (110 units) was also not significantly different.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 102 units. The historical site median and summer score were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 117 units. The historical site median and summer score were significantly lower than this value.

3.2.18.2.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 114). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Timaru Stream at SH45.



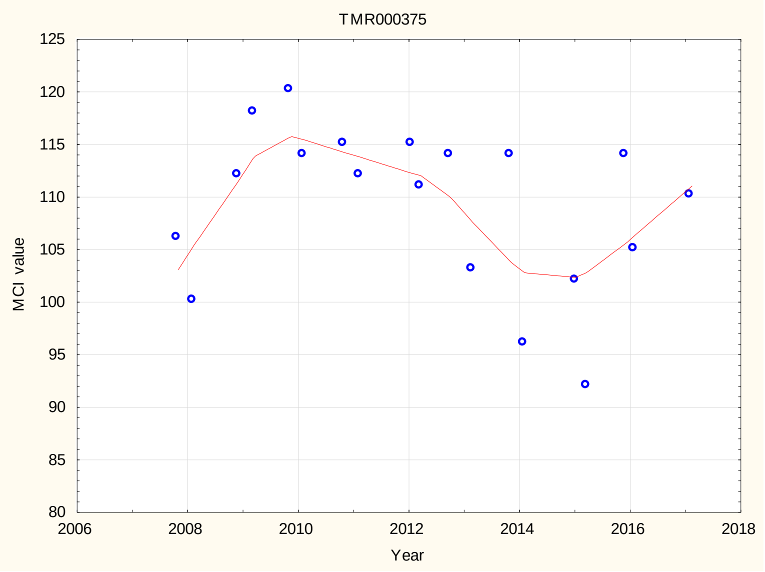
N = 43
Kendall tau = +0.401
p level < 0.001
FDR p < 0.001

Figure 114 LOWESS trend plot of MCI data at the SH45 site

MCI scores have shown a strong improvement over time (highly statistically significant), particularly since 2001, with most of the more recent scores (since 2004) well above scores recorded toward the start of the monitoring period. The trendline had a range over 18 units, an ecologically important range. The trendline indicated an improvement in generic stream 'health' (Table 2) from 'fair' to 'good'.

3.2.18.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 115). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Timaru Stream at SH45.



N = 19
Kendall tau = -0.258
p level = 0.123
FDR p = 0.432

Figure 115 LOWESS trend plot of ten years of data at the SH45 site

MCI scores have not shown any statistically significant improvement over the last ten years and overall there has been a decreasing trend. This contrasts with the full dataset which shows a significant, positive trend. An increasing trend from 2007-2010 has been offset by declines from 2010-2014. The trendline has ranged over 12 units and has indicated 'good' generic stream 'health' (Table 2).

3.2.18.3 Discussion

No spring survey was able to be completed due to persistently high flows. The summer survey indicated that the upper site had 'excellent' health while the lower site had 'good' health.

The MCI and $SQMCI_s$ scores fell in a downstream direction in summer, by 42 units and 2.3 units respectively, over a stream distance of 10.9 km downstream from the National Park boundary. This was typical for Timaru Stream and was likely due to the cumulative impacts of diffuse and point source inputs causing nutrient enrichment at the bottom site.

Time trend analysis indicated no change in macroinvertebrate community health over the full or ten year dataset for the upper site while the lower site showed a significant positive improvement over the full 22 year time period. No obvious explanations have been apparent for the positive trend but a possible reason may be related to improved management of dairy shed wastes disposal in the catchment above this SH45 site. No significant trend occurred over the more recent, ten year period.

3.2.19 Waiau Stream

The Waiau Stream is a small, lowland stream flowing south to north with a mouth situated east of Waitara. One SEM site is located in the mid reach of the stream. Due to persistently high flows no spring survey was able to be completed. The results found by the summer 2017 survey are presented in Table 155, Appendix I.

3.2.19.1 Inland North site (WAI000110)

3.2.19.1.1 Taxa richness and MCI

Thirty-five surveys have been undertaken in this mid-reach site in the Waiau Stream between February 1998 and March 2016. These results are summarised in Table 84, together with the results from the current period, and illustrated in Figure 116.

Table 84 Results of previous surveys performed in Waiau Stream at Inland North Road, together with the summer 2017 result

Site code	SEM data (1998 to March 2016)						2016-2017 survey	
	No of surveys	Taxa numbers		MCI values			Feb 2017	
		Range	Median	Range	Median		Taxa no	MCI
WAI000110	35	17-30	21	80-101	90		17	94

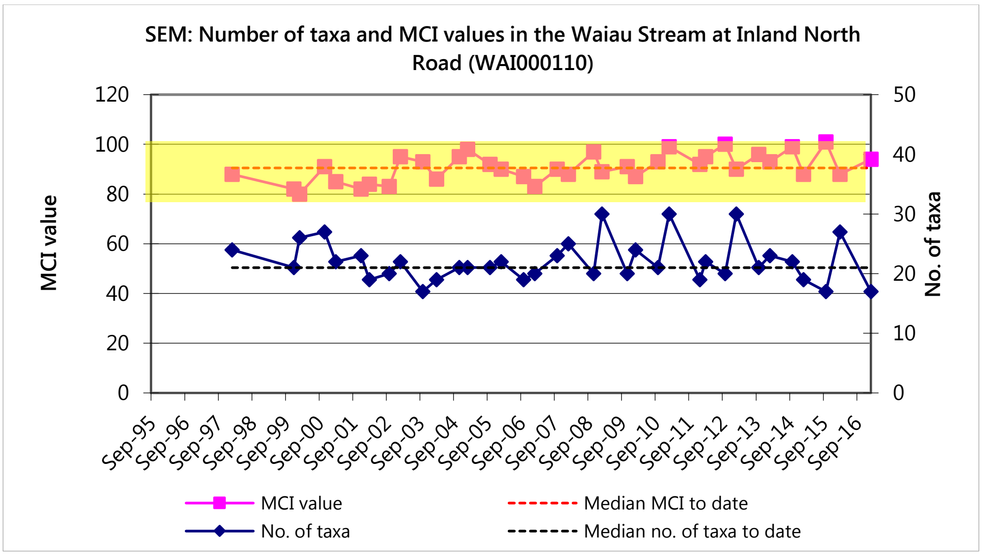


Figure 116 Numbers of taxa and MCI values in the Waiau Stream at the Inland North Road site

A moderate range of richnesses (17 to 30 taxa) has been found, with a median richness of 21 taxa (more representative of typical richnesses in small lowland coastal streams where a median richness of 20 taxa has been recorded from 111 previous surveys of 'control' sites at similar altitudes (TRC, 2016b)). During the 2016-2017 period the summer (17 taxa) richness was similar to the median richness.

MCI values have had a moderate range (21 units) to date at this site. The median value (90 units) is more typical of scores at sites in the lower reaches of small lowland streams and rivers. The summer score (94 units) was not significantly different to the historic median. The score categorised this site as having 'fair' (summer) health (Table 2). The historical median score (90 units) placed this site in the 'fair' category for the generic method of assessment.

3.2.19.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 85.

Table 85 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waiau Stream at Inland North Road between 1998 and March 2016 [35 surveys], and by the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
NEMERTEA	Nemertea	3	4			4	11	
ANNELIDA (WORMS)	Oligochaeta	1	18	6		24	69	A
MOLLUSCA	*Latia*	5	13			13	37	
	Potamopyrgus	4	6	16	12	34	97	XA
CRUSTACEA	*Paracalliope*	5	10	5	1	16	46	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	15	16	1	32	91	A
	Coloburiscus	7	1			1	3	
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	2			2	6	
COLEOPTERA (BEETLES)	Elmidae	6	6	24	5	35	100	VA

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	1			1	3	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	17	15	1	33	94	VA
	Hydrobiosis	5	13			13	37	
	Hudsonema	6	3			3	9	
	Oxyethira	2	8			8	23	
	Pycnocentria	7	13	4		17	49	
	Pycnocentrodes	5	13	14	2	29	83	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	15	2		17	49	
	Maoridiamesa	3	1			1	3	
	Orthocladiinae	2	20	5		25	71	
	Polypedilum	3	1			1	3	
	Tanytarsini	3	1			1	3	
	Austrosimulium	3	6			6	17	
ACARINA (MITES)	Acarina	5	1			1	3	

Prior to the current 2016-2017 period, 23 taxa had characterised the community at this site on occasions. These have comprised 13 'moderately sensitive' and ten 'tolerant' taxa i.e. an absence of 'highly sensitive' taxa and a relatively high proportion of 'tolerant' taxa as would be expected in the mid reaches of a lowland, coastal stream. Predominant taxa have included four 'moderately sensitive' taxa [amphipod (*Paracalliope*), mayfly (*Austroclima*), elmid beetles, and stony-cased caddisfly (*Pycnocentrodes*)] and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche -Aoteapsyche*), and orthoclad midges].

The summer 2017 community was characterised by six taxa that were a mixture of tolerant and sensitive taxa which was reflected in the $SQMCI_s$ score of 4.3 units indicating 'fair' health (Table 85) (Table 155).

3.2.19.1.3 Predicted stream 'health'

The Waiau Stream rises at an elevation of less than 100 m asl as seepage beyond the ringplain and the site at Inland North Road is in the mid reaches at an altitude of 50 m asl.

The median value for coastal streams of similar altitude (TRC, 2016b) was 79 units. The historical median and summer scores were significantly higher than the median value. The REC predicted MCI value (Leathwick, et al. 2009) was 91 units. The historical site median and summer scores were not significantly different from the REC predicted value.

3.2.19.1.4 Temporal trends in 1998 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 117). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 19 years of SEM results (1998-2017) from the site in the Waiau Stream at Inland North Road.

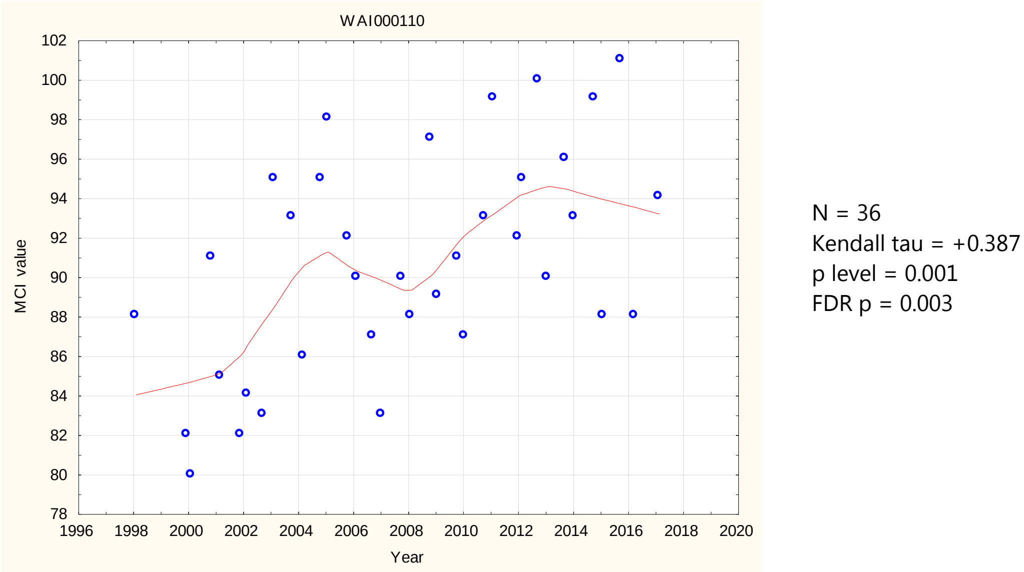


Figure 117 LOWESS trend plot of MCI data at the Inland North Road site, Waiau Stream

A significant positive temporal trend in MCI scores has been found (FDR p < 0.01) over the 19 year monitoring term at this site. The trend had two dips where scores declined and the current period is in the second of the two dips. The trendline range of scores (11 units) has been of significant ecological importance. Trendline scores have been indicative of 'fair' generic stream health (Table 2) throughout the period.

3.2.19.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 118). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waiau Stream at Inland North Road.

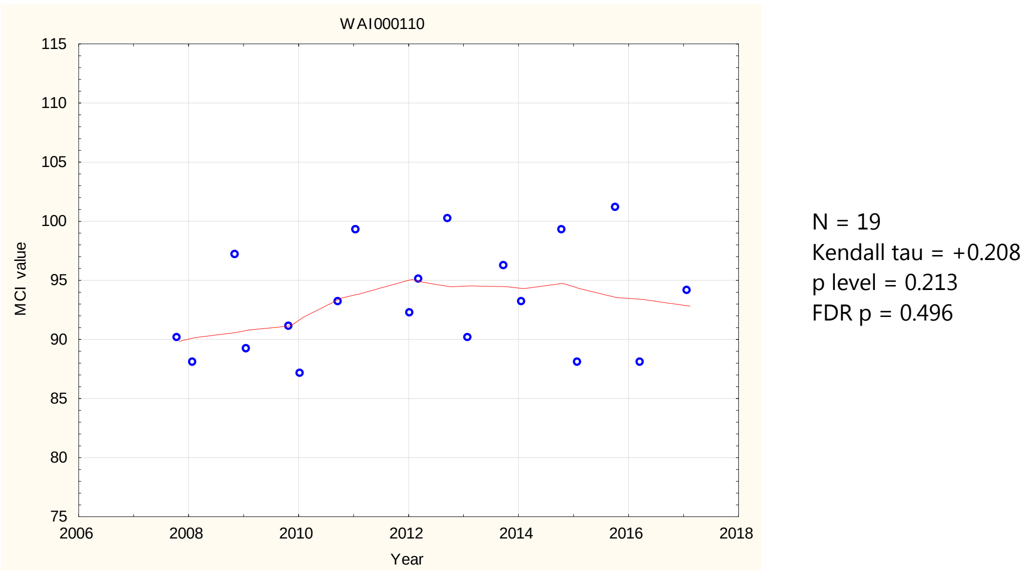


Figure 118 LOWESS trend plot of ten years of MCI data at the Inland North Road site, Waiau Stream

A non-significant positive trend in MCI scores after FDR adjustment was found in contrast with the highly significant result from the full dataset. However, the trend was significant prior to FDR adjustment. The trendline shows a marked increase from 2007-2012 but a subsequent slight decrease from 2012 onwards meant the overall positive trend was weak. The trendline range of scores have been indicative of 'fair' generic stream health (Table 2) throughout the period.

3.2.19.2 Discussion

No spring survey was able to be completed due to persistently high flows. Taxa richness was moderately low and slightly lower than in previous surveys equalling the lowest recorded taxa richness at the site of 17 taxa. Regular freshes and floods preceding the survey may have reduced taxa diversity at the site though taxa abundances were still relatively high with several taxa being highly abundant.

The summer survey indicated that the macroinvertebrate community was in 'fair' health which was typical for the site and significantly better than was typical for other lowland, coastal streams in Taranaki but was not significantly different to similar streams across the country.

3.2.20 Waimoku Stream

The Waimoku Stream is a small ringplain stream with a source inside Egmont National Park in the Kaitake Ranges and flows in an east to west direction. There are two SEM sites situated on the stream in the upper and lower reaches. No spring survey was able to be completed The results found by the 2016-2017 surveys are presented in Table 156, Appendix I.

3.2.20.1 Lucy's Gully site (WMK000100)

3.2.20.1.1 Taxa richness and MCI

Thirty-five surveys have been undertaken at this upper reach site in the Kaitake Ranges between December 1999 and February 2016. These results are summarised in Table 86, together with the results from the current period, and illustrated in Figure 119.

Table 86 Results of previous surveys performed in the Waimoku Stream at Lucy's Gully, together with the summer 2017 result

Site code	SEM data (1999 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
WMK000100	35	22-38	31	121-141	131	30	137

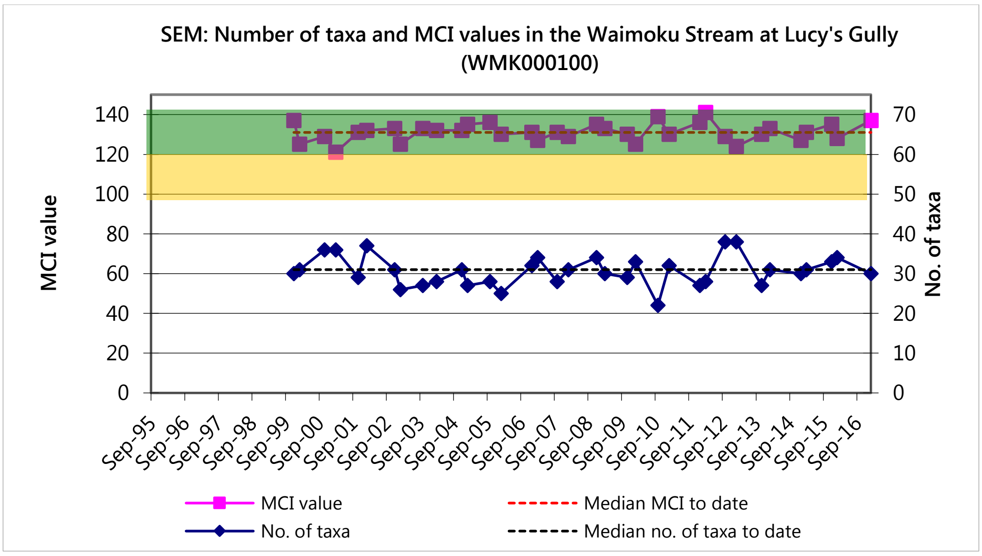


Figure 119 Numbers of taxa and MCI values in the Waimoku Stream at Lucy's Gully

A moderate range of richnesses (22 to 38 taxa) has been found, with a median richness of 31 taxa which is more representative of typical richnesses in the upper reaches of ringplain streams and rivers. During the 2016-2017 period the summer (30 taxa) richness was very similar to the historical median richness.

MCI values also have had a moderate range (20 units) at this site, slightly wider than typical of a site in the upper reaches of a ringplain stream. The median value (131 units) however, has been typical of upper reach sites elsewhere on the ringplain (TRC, 2016b). The summer 2017 (137 units) score was not significantly different from the historical median (Stark, 1998). This score categorised this site as having 'very good' health generically (Table 2). The historical median score (131 units) placed this site in the 'very good' health category.

3.2.20.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 87.

Table 87 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waimoku Stream at Lucy's Gully between 1999 and February 2016 [34 surveys], and summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	2		1	3	9	
MOLLUSCA	*Potamopyrgus*	4	5			5	15	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	15	9	1	25	74	VA
	Coloburiscus	7	7	26	1	34	100	VA
	Deleatidium	8	17	13		30	88	A
	Ichthybotus	8	1			1	3	
	Zephlebia group	7	20	10		30	88	A
PLECOPTERA (STONEFLIES)	*Austroperla*	9	26			26	76	
	Stenoperla	10	2			2	6	

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
	Zelandobius	5	1			1	3	
COLEOPTERA (BEETLES)	Elmidae	6	2			2	6	
	Ptilodactylidae	8	5			5	15	
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	3	1		4	12	
TRICHOPTERA (CADDISFLIES)	*Hydrobiosella*	9	8			8	24	
	Hydropsyche (Orthopsyche)	9	14	20		34	100	VA
DIPTERA (TRUE FLIES)	Orthocladiinae	2	17	2	1	20	59	
	Polypedilum	3	7	1		8	24	

Prior to the current 2016-2017 period, 17 taxa have characterised the community at this site on occasions. These have comprised seven 'highly sensitive', six 'moderately sensitive', and four 'tolerant' taxa i.e. a very high proportion of 'sensitive' taxa as would be expected in the upper reaches of a ringplain stream within the National Park's Kaitake Ranges. Predominant taxa have included three 'highly sensitive' taxa [mayfly (*Deleatidium*), stonefly (*Austroperla*), and free-living caddisfly (*Hydropsyche-Orthopsyche*)]; three 'moderately sensitive' taxa [mayflies (*Austroclima, Coloburiscus,* and *Zephlebia* group)]; and one 'tolerant' taxon [orthoclad midges]. The summer 2017 community had five characteristic taxa that were all sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.5 units indicating 'excellent' health (Table 87).

3.2.20.1.3 Predicted stream 'health'

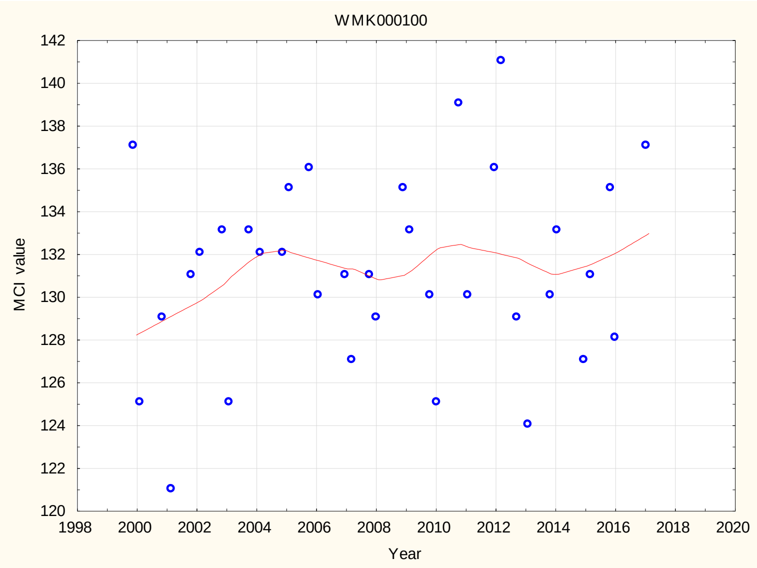
The Waimoku Stream site at Lucy's Gully is within the Kaitake Ranges of the National Park boundary but at an altitude of 160 m asl and only 4km from the coast.

Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median (131 units) was only one unit less than the distance predictive value. The summer score (137 units) was also not significantly different from the distance predictive value.

The median value for lowland coastal streams of similar (TRC, 2016b) was 108 units. The historical median and summer scores were all significantly higher indicating that the site had healthier macroinvertebrate communities compared with similar streams in Taranaki. The REC predicted MCI value (Leathwick, et al. 2009) was 128 units. The historical site median and summer scores were not significantly different to the REC predictive score.

3.2.20.1.4 Temporal trends in 1999 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 120). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 18 years of SEM results (1999-2017) from the site in the Waimoku Stream at Lucy's Gully.



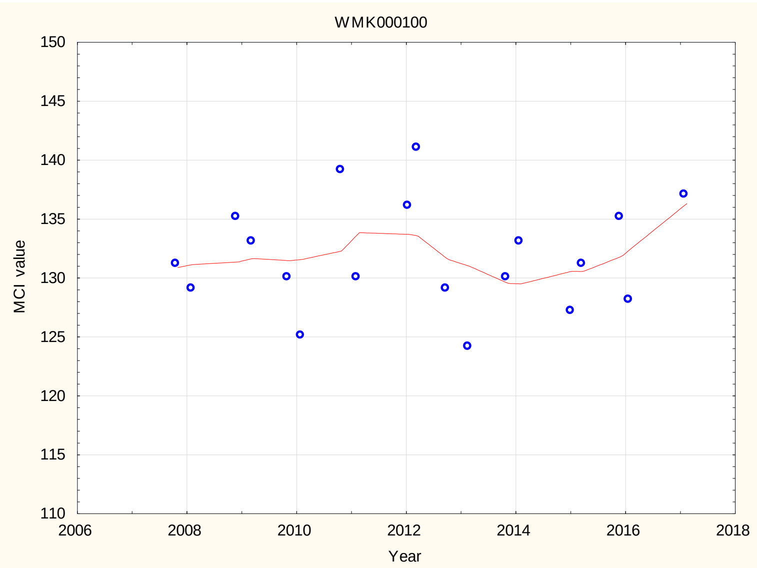
N = 35
Kendall tau = +0.062
p level = 0.599
FDR p = 0.732

Figure 120 LOWESS trend plot of MCI data at the Lucy's Gully site, Waimoku Stream

No significant trend in MCI scores has been found over the 18 year period at this pristine site within the National Park. The trendline range of scores (five units) has not been ecologically important and these MCI scores have continuously indicated 'very good' generic stream health (Table 2).

3.2.20.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 121). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on ten years of SEM results (2007-2017) from the site in the Waimoku Stream at Lucy's Gully.



N = 19
Kendall tau =+ 0.012
p level = 0.943
FDR p = 0.946

Figure 121 LOWESS trend plot of ten years of MCI data at the Lucy's Gully site, Waimoku Stream

No significant trend in MCI scores has been found over the ten year period at this pristine site within the National Park congruent with the results of the full dataset. The trendline has continuously indicated 'very good' generic stream health (Table 2).

3.2.20.2 Oakura Beach site (WMK000298)

3.2.20.2.1 Taxa richness and MCI

Thirtyfour surveys have been undertaken at this lower reach site at Oakura Beach in the Waimoku Stream between December 1999 and February 2016. These results are summarised in Table 46, together with the results from the current period, and illustrated in Figure 122.

Table 88 Results of previous surveys performed in the Waimoku Stream at Oakura Beach together with summer 2017 result

Site code	SEM data (1999 to February 2016)					2016-2017 survey	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
WMK000298	34	10-27	21	75-101	92	29	94

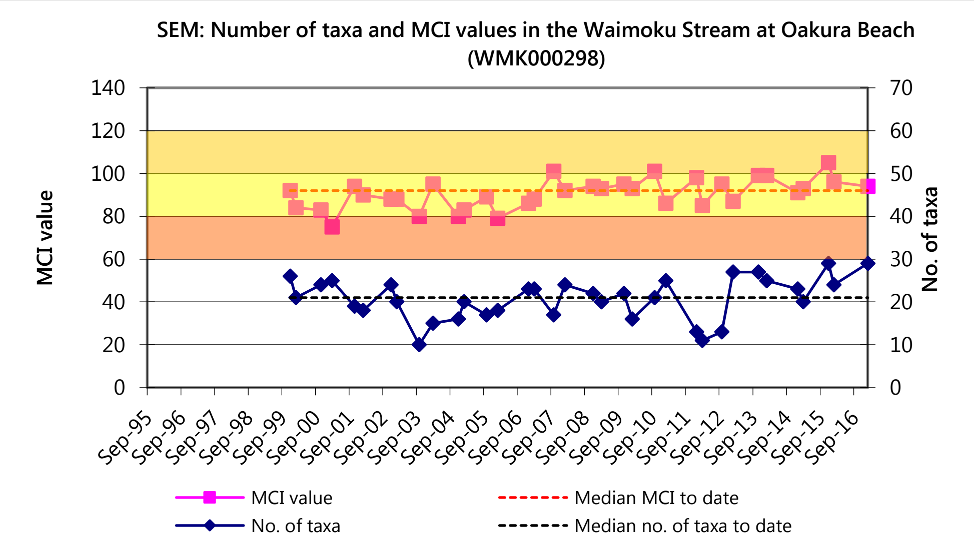


Figure 122 Numbers of taxa and MCI values in the Waimoku Stream at Oakura Beach

A wide range of richness (10 to 27 taxa) has been found; wider than might be expected, with a median richness of 21 taxa which was more representative of typical richnesses in ringplain streams and rivers in the lower reaches. During the 2016-2017 period, summer (29 taxa) richness was higher than the median taxa number by eight taxa and was the highest equal recorded taxa number at the site to date.

MCI scores have had a relatively wide range (26 units) at this site, typical of sites in the lower reaches of ringplain streams. The summer 2017 (94 units) score was not significantly different to the historical median. The summer score categorised this site as having ‘fair’ (summer) health generically (Table 2).

3.2.20.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 89.

Table 89 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waimoku Stream at Oakura Beach between 1999 and February 2016 [34 surveys], and by the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
NEMERTEA	Nemertea	3	3			3	9	
ANNELIDA (WORMS)	Oligochaeta	1	16	7	1	24	71	
MOLLUSCA	*Potamopyrgus*	4	4	9	11	24	71	XA
	Sphaeriidae	3	1			1	3	
CRUSTACEA	Ostracoda	1		1		1	3	
	Paratya	3	1			1	3	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	8	1		9	26	A
	Coloburiscus	7	5	1		6	18	
	Deleatidium	8	2			2	6	
	Zephlebia group	7	3			3	9	A
COLEOPTERA (BEETLES)	Elmidae	6	1	1		2	6	
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	8			8	24	
	Oxyethira	2	3			3	9	
	Pycnocentrodes	5	2			2	6	A
	Triplectides	5	4			4	12	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	8			8	24	VA
	Maoridiamesa	3	4	1		5	15	
	Orthocladiinae	2	13	12	7	32	94	A
	Polypedilum	3	5	2		7	21	
	Empididae	3	2			2	6	
	Austrosimulium	3	10	2		12	35	

Prior to the current 2016-2017 period 19 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', six 'moderately sensitive', and twelve 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly' or 'moderately sensitive' taxa, but three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges]. In the summer 2017 community there were seven characteristic taxa in the summer survey comprising a mixture of moderate and tolerant taxa which was reflected in the SQMCI$_S$ score of 4.3 units indicating 'fair' health (Table 89).

3.2.20.2.3 Predicted stream 'health'

The Waimoku Stream at Oakura Beach site at an altitude of 1 m asl is only 4 km downstream of the National Park boundary. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 116 for this site. The historical site median (92 units) is a significant 24 units lower than the predictive distance value, due to the atypically short distance between the National Park boundary and the coast for a ringplain stream. The summer 2017 score (94 units) was not significantly different to the distance predictive value.

The median value for ringplain streams of similar altitude (TRC, 2016b) was 90 units. The historical median and summer scores were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 103 units. The historical site median was significantly lower to the REC predictive value.but the summer score was not significantly different.

3.2.20.2.4 Temporal trends in 1999 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 123). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 18 years of SEM results (1999-2017) from the site in the Waimoku Stream at Oakura Beach.

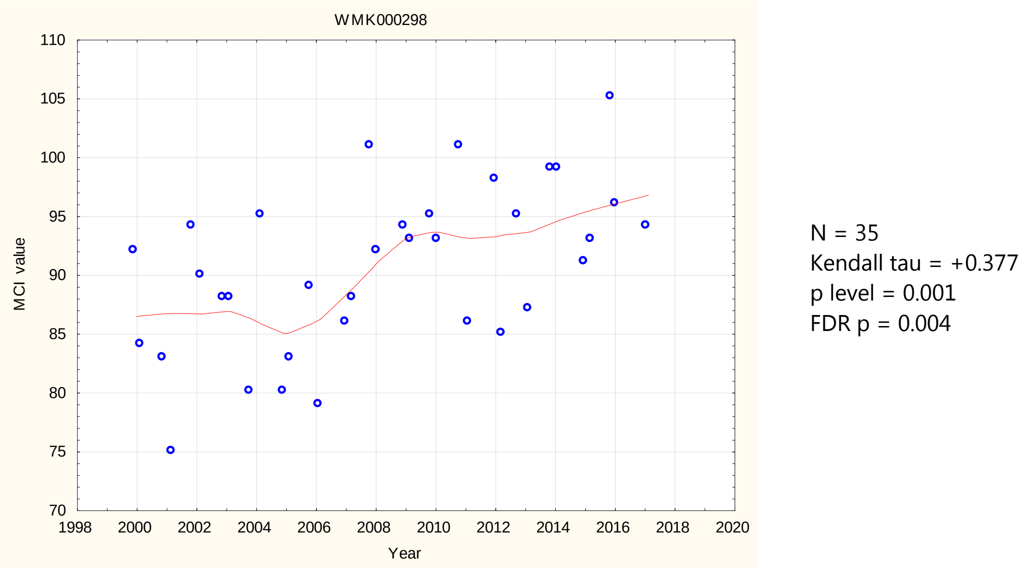
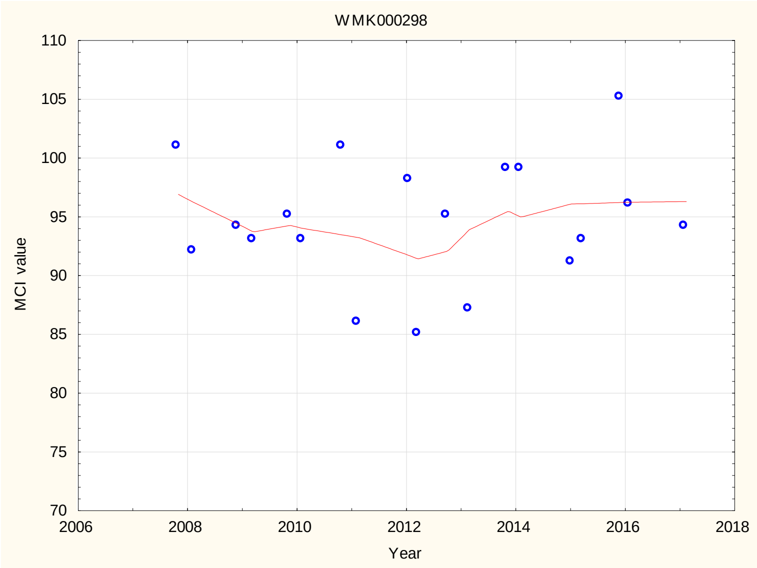


Figure 123 LOWESS trend plot of MCI data at the Oakura Beach site, Waimoku Stream

An overall positive significant trend in MCI scores has been recorded during the 18 year monitoring period (FDR $p < 0.01$) indicating an improvement in macroinvertebrate health. The trendline range of scores (12 units) has been ecologically important and has consistently indicated 'fair' generic stream health (Table 2) at this site in the lower reaches of the stream.

3.2.20.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 124). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on ten most recent years of SEM results (2007-2017) from the site in the Waimoku Stream at Oakura Beach.



N = 19
Kendall tau = +0.072
p level = 0.668
FDR p = 0.850

Figure 124 LOWESS trend plot of ten years of MCI data at the Oakura Beach site, Waimoku Stream

A positive non-significant trend in MCI scores has been recorded during the ten year monitoring period contrasting with the positive highly significant improvement found in the full dataset. Very little change occurred during the ten year period. The trendline has consistently indicated 'fair' generic stream health (Table 2) at this site in the lower reaches of the stream.

3.2.20.3 Discussion

No spring survey was able to be completed due to persistently high flows. Taxa richnesses were moderately high at both sites and the equal highest ever recorded at the lower site.

The summer survey indicated that the macroinvertebrate community at the upper site was in 'very good' health with the lower site was in 'fair' health. Macroinvertebrate health was typical for both sites. The MCI score fell in a downstream direction in summer by 43 units over a short stream distance of only 4.0 km downstream from the National Park boundary. This was a very large decrease in condition for a relatively short distance and greater than what would be expected given the relatively intact upper catchment. This may be due to significant nutrient enrichment and/ or habitat degradation at the lower site.

The time trend analysis indicated no trends at the upper site which would be expected given its pristine nature. The lower site had a significant positive trend over the full dataset indicating that macroinvertebrate health had improved though improvements may have plateaued over the last ten years. Increases in the amount of riparian fencing and planting of waterways in the catchment have probably contributed to this improvement.

3.2.21 Waingongoro River

The Waingongoro River is a large ringplain river with a source inside Egmont National Park. The river flows approximately north to south and there are six SEM sites situated along the length of the river. The results of the 2016-2017 surveys are summarised in Table 157 and Table 158, Appendix I.

3.2.21.1 Site near National Park boundary (WGG000115)

3.2.21.1.1 Taxa richness and MCI

Forty-two surveys have been undertaken at this upper reach site, 700m downstream of the National Park boundary in the Waingongoro River, between October 1995 and March 2016. These results are summarised in Table 90, together with the results from the current period, and illustrated in Figure 125.

Table 90 Results of previous surveys performed in the Waingongoro River 700m downstream of the National Park, together with spring 2016 and summer 2017 results

Site code	SEM data (2007 to March 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000115	42	24-40	32	122-144	132	32	129	23	133

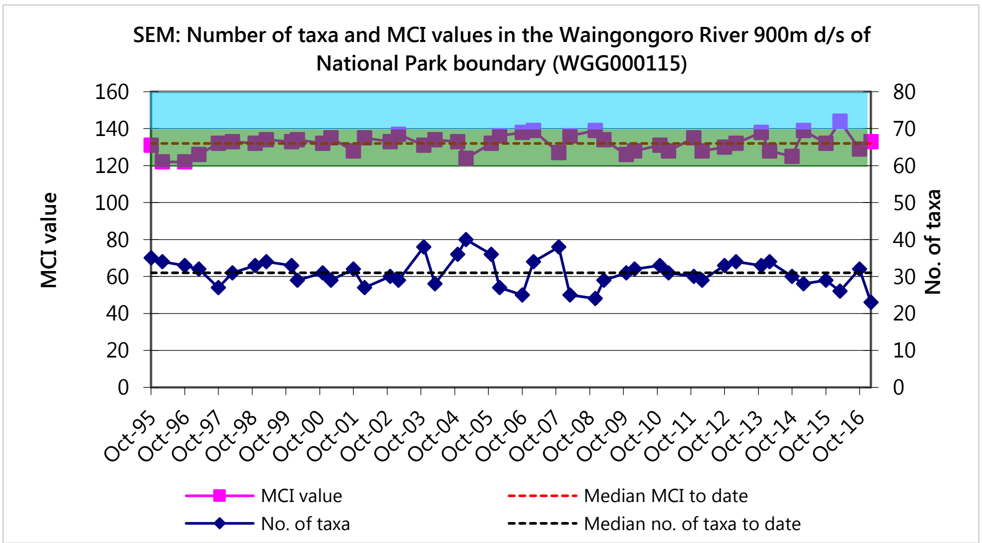


Figure 125 Numbers of taxa and MCI values in the Waingongoro River 700 m d/s National Park

A relatively wide range of richnesses (24 to 40 taxa) has been found with a high median richness of 32 taxa, typical of richnesses in ringplain streams and rivers near the National Park boundary. During the 2016-2017 period, spring (32 taxa) richness was similar to, and summer (23 taxa) richness slightly less than, the historic median.

MCI values have had a moderate range (22 units) at this site, typical of a National Park boundary site. The median value (132 units) has also been typical of upper reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (129 units) and summer 2017 (133 units) scores were not significantly different from the historical median. The MCI scores categorised this site as having 'very good' health generically (Table 2). The historical median score (132 units) placed this site in the 'very good' category for generic health.

3.2.21.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 65.

Table 91 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waingongoro River 700 m downstream of the National Park between 1995 and March 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	19	5		24	57		
	Coloburiscus	7	8	19	15	42	100	A	A
	Deleatidium	8	7	8	27	42	100	XA	VA
	Nesameletus	9	18	4	1	23	55	A	
PLECOPTERA (STONEFLIES)	*Acroperla*	5	3			3	7		
	Austroperla	9	3			3	7		
	Megaleptoperla	9	35	2		37	88		A
	Stenoperla	10	3			3	7		
	Zelandobius	5	2			2	5	A	
	Zelandoperla	8	12	21	9	42	100	VA	VA
COLEOPTERA (BEETLES)	Elmidae	6	21	21		42	100	A	A
	Hydraenidae	8	24	4		28	67		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	7			7	17		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	32	5		37	88		
	Beraeoptera	8	20	12	1	33	79	A	
	Helicopsyche	10	19	2		21	50	A	
	Olinga	9	24	4		28	67	A	A
	Pycnocentrodes	5	1			1	2		
	Zelolessica	7	11	2		13	31		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	21	21		42	100	A	
	Maoridiamesa	3	2			2	5		
	Orthocladiinae	2	17	1		18	43		

Prior to the current 2016-2017 period, 22 taxa had characterised the community at this site on occasions. These have comprised ten 'highly sensitive', nine 'moderately sensitive', and three 'tolerant' taxa i.e. a high proportion of 'highly sensitive' taxa as might be expected in the upper reaches of a ringplain river near the National Park. Predominant taxa have included eight 'highly sensitive' taxa [mayflies (*Nesameletus* and *Deleatidium*), stoneflies (*Megaleptoperla* and *Zelandoperla*), hydraenid beetles, and cased caddisflies (*Beraeoptera, Helicopsyche,* and *Olinga*)]; four 'moderately sensitive' taxa [mayflies (*Coloburiscus* and *Austroclima*), elmid beetles, and cranefly (*Aphrophila*)]; and only one 'tolerant' taxon [free-living caddisfly

(*Hydropsyche-Aoteapsyche*)]. Five of these taxa have been characteristic of communities on every occasion to date.

The spring 2016 community was characterised by ten taxa that were all sensitive taxa that was reflected in the high $SQMCI_s$ score of 7.8 units which indicated 'excellent' health. The summer 2017 community was characterised by six taxa which were sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.7 units which indicated 'excellent' health (Table 91) (Table 157 and Table 158).

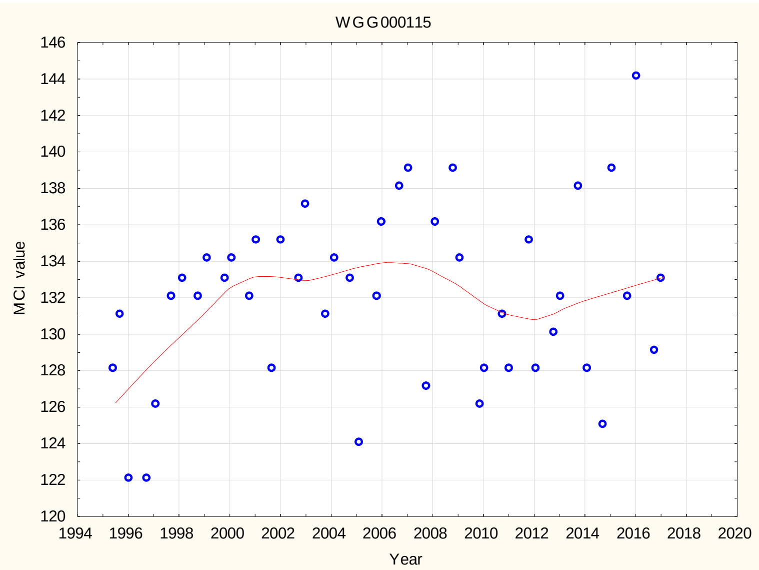
3.2.21.1.3 Predicted stream 'health'

The Waingongoro River site near the National Park is 0.7 km downstream of the National Park boundary at an altitude of 540 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median, spring and summer scores were not significantly different to the distance predictive value.

The median value for a ringplain river arising within the National Park at similar altitude (TRC, 2016b) was 134 units. The historical median, spring and summer and scores were all not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 131 units. The historical median, spring and summer and scores were also all not significantly different to this value.

3.2.21.1.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 126). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waingongoro River near the National Park.



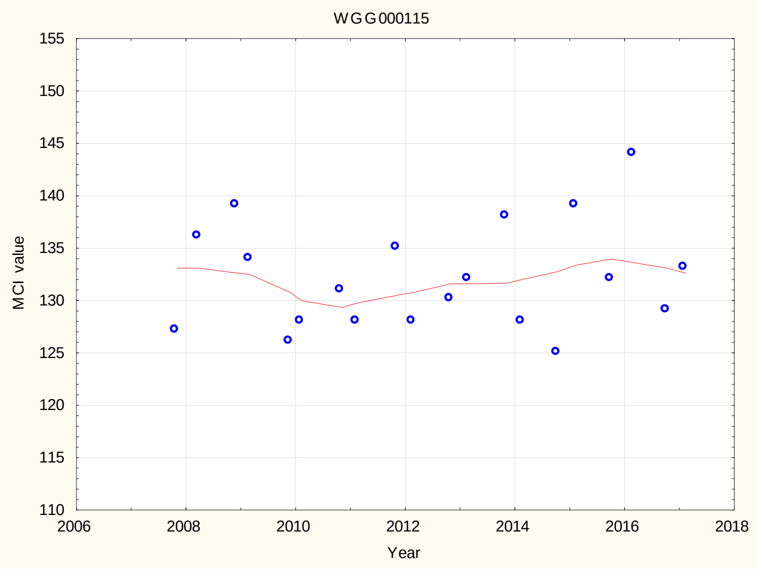
N = 45
Kendall tau = +0.143
p value = 0.167
FDR p = 0.244

Figure 126 LOWESS trend plot of MCI data at the site near the National Park, Waingongoro River

A positive, non-significant trend has been found over the 22-year period. This has not been statistically significant at the 5% level however, although previously (prior to 2008) there had been a statistically significant improvement over the earlier period (1995-2007). After 2007 there was some decline followed by some very recent improvement but the overall trendline range of scores (eight units) remains less than ecologically important. Throughout the period, the trend has indicated 'very good' generic river health (Table 2).

3.2.21.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 127). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waingongoro River near the National Park.



N = 20
Kendall tau = +0.129
p value = 0.426
FDR p = 0.645

Figure 127 LOWESS trend plot of ten years of MCI data at the site near the National Park, Waingongoro River

A non-significant postive trend in MCI scores was found at this site which was congruent with the full dataset. The trendline was in the 'very good' generic river health (Table 2) range.

3.2.21.2 Opunake Road site (WGG000150)

3.2.21.2.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Waingongoro River at this upper mid-reach site at Opunake Road (approximately 7km downstream of the National Park) between October 1995 and March 2016. These results are summarised in Table 92, together with the results from the current period, and illustrated in Figure 128.

Table 92 Results of previous surveys performed in the Waingongoro River at Opunake Road together with spring 2016 and summer 2017 results.

Site code	SEM data (1995 to March 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000150	42	23-39	27	119-139	129	22	121	22	124

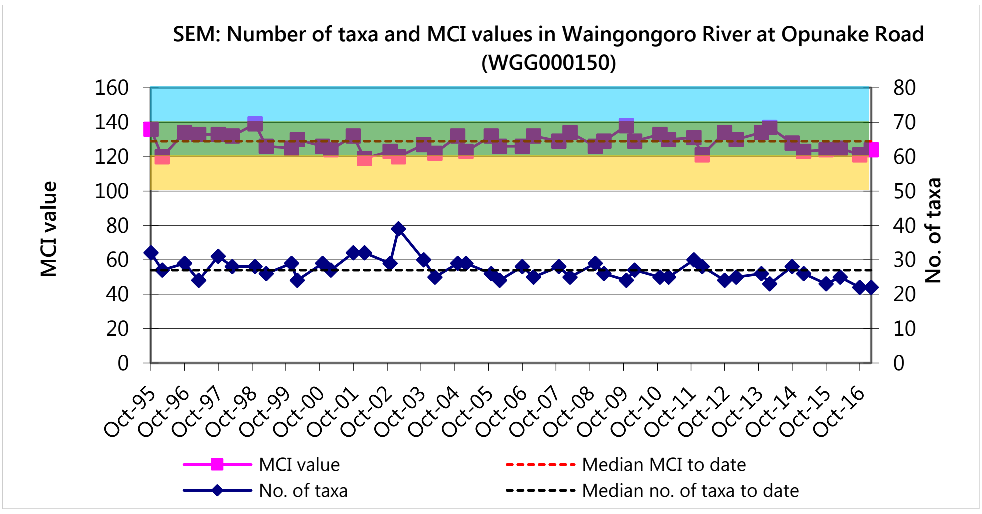


Figure 128 Numbers of taxa and MCI values in the Waingongoro River at Opunake Road

A relatively wide range of richnesses (23 to 39 taxa) has been found; wider than might be expected, with a median richness of 27 taxa (more representative of typical richnesses in the upper mid reaches of ringplain streams and rivers). During the 2016-2017 period spring (22 taxa) and summer (22 taxa) richnesses were slightly lower than the historic median.

MCI values have had a moderate range (20 units) at this site, typical of sites in the upper mid reaches of ringplain rivers. The median value (129 units) has been higher typical of upper, mid reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (121 units) and summer 2017 (124 units) scores were not significantly lower than the median value (Stark, 1998). These scores categorised this site as having 'very good' (spring and summer) health generically (Table 2). The historical median score (130 units) placed this site in the 'very good' category for generic health.

3.2.21.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 93.

Table 93 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waingongoro River at Opunake Road between 1995 and March 2016 [43 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	2			2	5		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	22	10	1	33	79		A
	Coloburiscus	7	6	14	22	42	100	VA	A
	Deleatidium	8	8	9	25	42	100	VA	VA
	Nesameletus	9	27	6	2	35	83		A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	1			1	2		
	Megaleptoperla	9	2			2	5		
	Zelandoperla	8	22	8	1	31	74	A	A
COLEOPTERA (BEETLES)	Elmidae	6	25	15	2	42	100	A	A

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
	Hydraenidae	8	24			24	57		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	27	1		28	67	A	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	27	8		35	83		A
	Costachorema	7	1			1	2		
	Hydrobiosis	5	5			5	12		
	Beraeoptera	8	13	18	2	33	79	A	
	Confluens	5	3			3	7		
	Helicopsyche	10	2			2	5		
	Olinga	9	10			10	24		
	Pycnocentrodes	5	14		1	15	36		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	25	17		42	100		A
	Eriopterini	5	1			1	2		
	Orthocladiinae	2	6			6	14		
	Polypedilum	3	1			1	2		

Prior to the current 2016-2017 period, 23 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', twelve 'moderately sensitive', and three 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected toward the upper mid-reaches of a ringplain stream. Predominant taxa have included five 'highly sensitive' taxa [mayflies (*Deleatidium* on every sampling occasion, and *Nesameletus*), stonefly (*Zelandoperla*), hydraenid beetles, and cased caddisfly (*Beraeoptera*)]; five 'moderately sensitive' taxa [mayflies (*Coloburiscus* and *Austroclima*), elmid beetles, dobsonfly (*Archichauliodes*), and cranefly (*Aphrophila*)]; and one 'tolerant' taxon [net-building caddisfly (*Hydropsyche-Aoteapsyche*)].

The spring 2016 community had six characteristic taxa that were all sensitive taxa which was reflected in the high $SQMCI_s$ value of 7.2 units indicating 'excellent' health. The summer 2017 community had eight characteristic taxa that were mostly sensitive taxa which was reflected in the high $SQMCI_s$ value of 7.1 units indicating 'excellent' health (Table 157 and Table 158).

3.2.21.2.3 Predicted stream 'health'

The Waingongoro River site at Opunake Road is 7.2 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 110 for this site. The historical site median, spring and summer scores were not significantly different from the distance predictive value.

The median value for a ringplain river arising within the National Park at similar altitude (TRC, 2016b) was 129 units. The historical site median, spring and summer scores were not significantly different from this value.The REC predicted MCI value (Leathwick, et al. 2009) was 124 units. The historical site median, spring and summer scores were also not significantly different from this value.

3.2.21.2.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 129). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waingongoro River at Opunake Road.

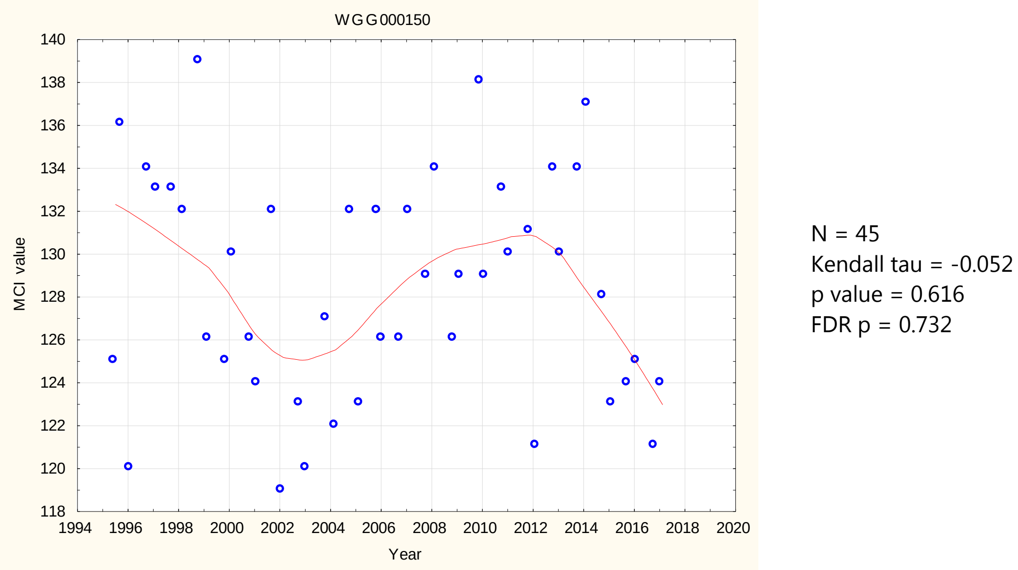
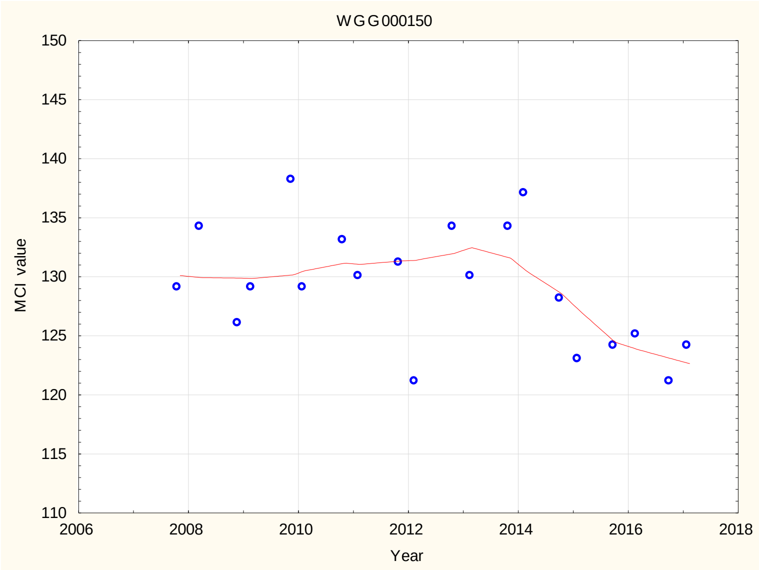


Figure 129 LOWESS trend plot of MCI data at the Opunake Road site, Waingongoro River

An overall temporal trend of virtually no change in MCI scores has occurred in the upper mid-reaches of the river (some seven km below the National Park). The trendline range of scores (six units) has not been ecologically important over the 22 year period. Localised erosion had caused sediment deposition on the riverbed during 1999 with a subsequent five year decline in MCI scores which was of minor ecological importance (nine units). This decline ceased with a gradual improvement in MCI scores towards earlier levels over the latter twelve years. The erosion event was very localised and site specific, as corresponding biological and physiochemical monitoring data showed no significant trends at the nearest downstream site (Eltham Road). The trendline range of scores have been consistently indicative of 'very good' generic river health although trending downward toward 'good' immediately following the erosion event (Table 2).

3.2.21.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 130). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten more recent years of SEM results (2007-2017) from the site in the Waingongoro River at Opunake Road.



N = 20
Kendall tau = -0.275
p value = 0.090
FDR p = 0.381

Figure 130 LOWESS trend plot of ten years of MCI data at the Opunake Road site, Waingongoro River

A minor non-significant negative trend in MCI scores has occurred in the upper mid-reaches of the river (some seven km below the National Park). Though a decrease in the trend was apparent from 2014 to 2015 overall the trend was non-significant congruent with the results from the full dataset. The trendline was indicative of 'very good' generic river health 'good' (Table 2).

3.2.21.3 Eltham Road site (WGG000500)

3.2.21.3.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Waingongoro River at this mid-reach site at Eltham Road between October 1995 and March 2016. These results are summarised in Table 94, together with the results from the current period, and illustrated in Figure 131.

Table 94 Results of previous surveys performed in the Waingongoro River at Eltham Road, together with spring 2016 and summer 2017 results.

Site code	SEM data (1995 to March 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000500	42	16 - 32	22	91-124	103	21	101	22	104

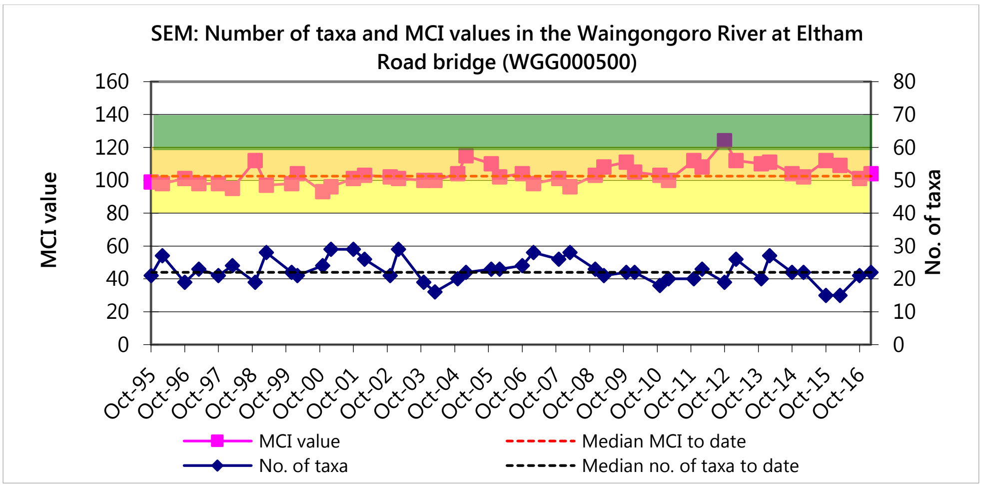


Figure 131 Numbers of taxa and MCI values in the Waingongoro River at Eltham Road

A wide range of richnesses (16 to 32 taxa) has been found with a median richness of 22 taxa, typical of richnesses in the mid reaches of ringplain streams and rivers. During the 2016-2017 period spring (21 taxa) and summer (22 taxa) richnesses were very similar to the historic median.

MCI values have had a relatively wide range (33 units) at this site, more typical of sites in the mid reaches of ringplain rivers. The historical median value (103 units) has been typical of mid reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (101 units) and summer 2017 (104 units) scores were both not significantly different to the historical median. These scores categorised this site as having 'good' (spring and summer) health generically (Table 2). The historical median score (103 units) placed this site in the 'good' category for generic health.

3.2.21.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 95.

Table 95 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waingongoro River at Eltham Road between 1995 and March 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	4			4	9		
ANNELIDA (WORMS)	Oligochaeta	1	7	5		12	26		
MOLLUSCA	*Potamopyrgus*	4	6	1		7	15		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	9	3		12	26		
	Coloburiscus	7	21	8		29	63	A	A
	Deleatidium	8	3	9	23	35	76	VA	XA
	Nesameletus	9	1			1	2		
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	7	1		8	17		
COLEOPTERA (BEETLES)	Elmidae	6	12	21	11	44	96	A	A
	Hydraenidae	8	1			1	2		
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	24	2		26	57		

Taxa List		MCI score	A	VA	XA	Tot al	%	Survey	
								Spring 2016	Summer 2017
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	11	17	10	38	83		VA
	Costachorema	7	16			16	35		
	Hydrobiosis	5	25	3		28	61		
	Beraeoptera	8	1			1	2		
	Oxyethira	2	2			2	4		
	Pycnocentrodes	5	12	2		14	30	A	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	9			9	20		
	Eriopterini	5	7			7	15		
	Maoridiamesa	3	10	5	2	17	37		
	Orthocladiinae	2	15	6	3	24	52		
	Tanytarsini	3	8	1		9	20		
	Ceratopogonidae	3	1			1	2		
	Empididae	3	3			3	7		
	Austrosimulium	3	13			13	28		

Prior to the current 2016-2017 period, 25 taxa had characterised the community at this site on occasions. These have comprised four 'highly sensitive', ten 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increase in 'tolerant' taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Hydrobiosis*), and dobsonfly (*Archichauliodes*)]; and two 'tolerant' taxa [free-living caddisfly (*Hydropsyche-Aoteapsyche*) and orthoclad midges]. The spring 2016 community consisted of four historically characteristic taxa that were all sensitive taxa which was reflected in the high $SQMCI_s$ score of 6.6 units indicating 'very good' health. The summer 2017 community consisted of four historically characteristic taxa that were mostly sensitive taxa which was reflected in the high $SQMCI_s$ score of 7.2 units indicating 'excellent' health (Table 95) (Table 157 and Table 158).

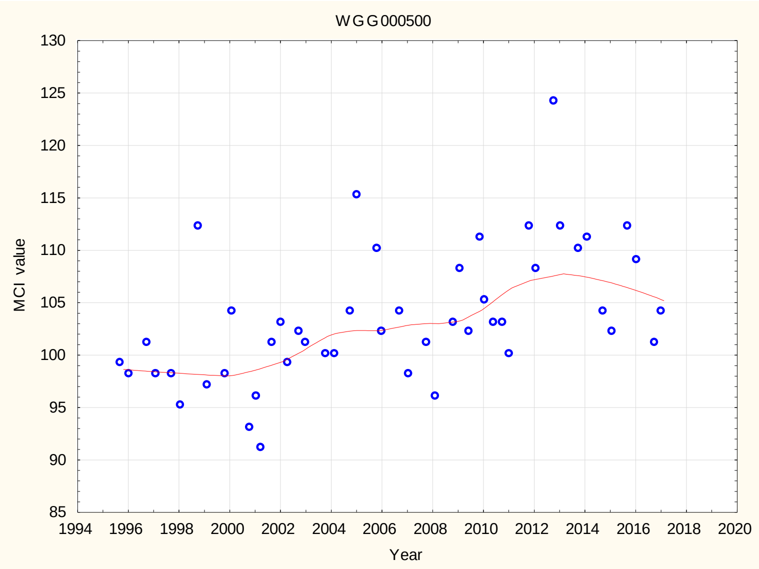
3.2.21.3.3 Predicted stream 'health'

The Waingongoro River site at Eltham Road is 23.0 km downstream of the National Park boundary at an altitude of 200 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 97 for this site. The historical site median, spring and summer survey scores were all not significantly different to the distance predictive value (Stark, 1998).

The median value for a ringplain river arising within the National Park at similar altitude (TRC, 2016b) was 101 units. The historic median, spring and summer scores were all not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 110 units. Again, the historic median, sprin and, summer scores were not significantly different to this value.

3.2.21.3.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 132). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waingongoro River at Eltham Road.



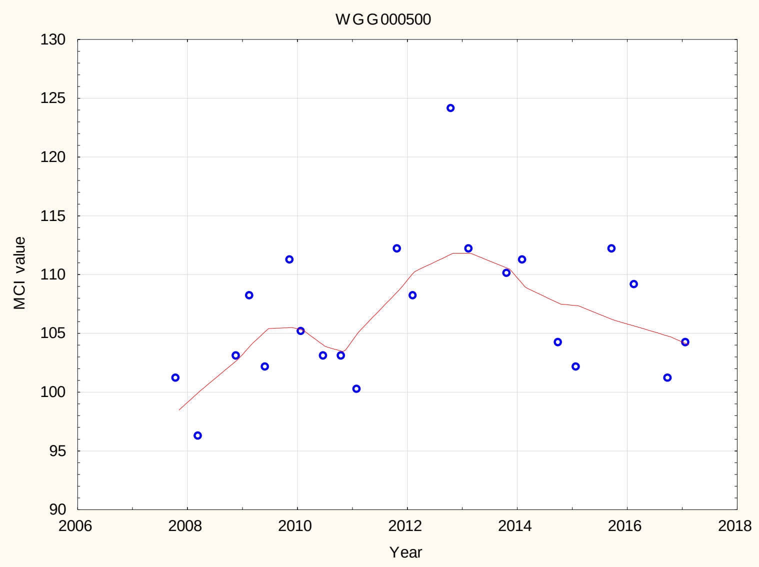
N = 48
Kendall tau = +0.416
p value < 0.001
FDR p < 0.001

Figure 132 LOWESS trend plot of MCI data at the Eltham Road site, Waingongoro River

A significant positive temporal trend in MCI scores has been found over the 22 year period (FDR p< 0.01). This has been more pronounced since 2001 but scores plateaued for about three years before a more recent further improvement and another most recent plateau in scores. The trendline range of scores (10 units) has been of marginal ecological importance over the 22 year period due to the recent plateau in scores. The trendline MCI scores consistently bordered averaged 'fair' generic health (Table 2) prior to 2003 and since then have been in the 'good' category.

3.2.21.3.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 133). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waingongoro River at Eltham Road.



N = 22
Kendall tau = +0.204
p value = 0.184
FDR p = 0.484

Figure 133 LOWESS trend plot of ten years of MCI data at the Eltham Road site, Waingongoro River

A non-significant positive trend in MCI scores has been found over the ten year period in contrast with the full dataset which had a positive, highly significant, trend. The trendline was in the 'good' generic health category (Table 2).

3.2.21.4 Stuart Road site (WGG000665)

3.2.21.4.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Waingongoro River at this mid-reach site at Stuart Road between October 1995 and March, 2016. These results are summarised in Table 96, together with the results from the current period, and illustrated in Figure 134.

Table 96 Results of previous surveys performed in the Waingongoro River at Stuart Road, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to March 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000665	44	14 - 30	20	77-111	95	14	104	20	101

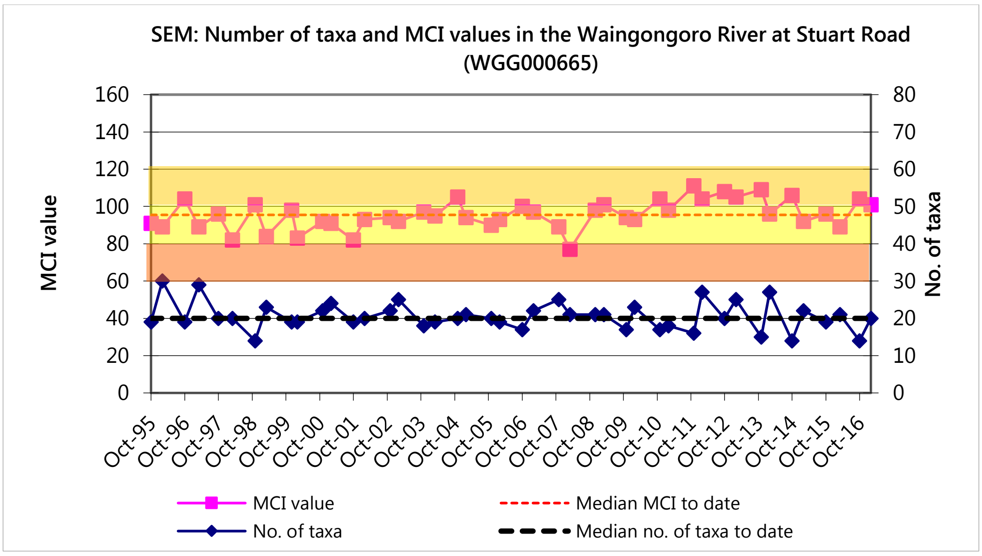


Figure 134 Numbers of taxa and MCI values in the Waingongoro River at Stuart Road

A wide range of richnesses (14 to 30 taxa) has been found with a median richness of 20 taxa (more representative of typical richnesses in the mid reaches of ringplain streams and rivers). During the 2016-2017 period spring (14 taxa) and summer (20 taxa) richnesses were very similar to the historic median (20 taxa).

MCI values have had a moderately wide range (34 units) at this site, typical of sites in the mid reaches of ringplain rivers. The median value (95 units) has been lower than typical of mid reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (104 units) and summer 2017 (101 units) scores were not significantly different to the historic median. These scores categorised this site as having 'good' (spring and summer) health generically (Table 2). The historical median score (95 units) placed this site in the 'fair' category for generic health.

3.2.21.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 97.

Table 97 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waingongoro River at Stuart Road between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	1			1	2		
ANNELIDA (WORMS)	Oligochaeta	1	16	1	1	18	43		
CRUSTACEA	Ostracoda	1	1			1	2		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	7	1		8	19		
	Coloburiscus	7	5			5	12		
	Deleatidium	8	6	9	11	26	62	VA	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	3			3	7		
COLEOPTERA (BEETLES)	Elmidae	6	17	14		31	74		

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	3			3	7		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	11	13	8	32	76		VA
	Costachorema	7	7			7	17		
	Hydrobiosis	5	13	2		15	36		
	Beraeoptera	8	2			2	5		
	Oxyethira	2	1			1	2		
	Pycnocentrodes	5	5	4	1	10	24		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	16			16	38		
	Maoridiamesa	3	12	10	5	27	64		VA
	Orthocladiinae	2	21	16	1	38	90		A
	Tanytarsini	3	10	1		11	26		A
	Ceratopogonidae	3	1			1	2		
	Empididae	3	2			2	5		
	Austrosimulium	3	10	1		11	26		

Prior to the current 2016-2017 period, 22 taxa had characterised the community at this site on occasions. These have comprised two 'highly sensitive', nine 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a higher proportion of 'tolerant' taxa as might be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; one 'moderately sensitive' taxon [elmid beetles]; and three 'tolerant' taxa [free-living caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. The spring 2016 community consisted of one historically characteristic taxon that was a 'sensitive' taxon which was reflected in the high $SQMCI_s$ score of 7.2 units indicating 'excellent' health. The summer 2017 community consisted of five characteristic taxa comprising one 'sensitive', and four 'tolerant' taxa which was reflected in the moderate $SQMCI_s$ score of 4.8 units indicating 'fair' health (Table 97) (Table 157 and Table 158).

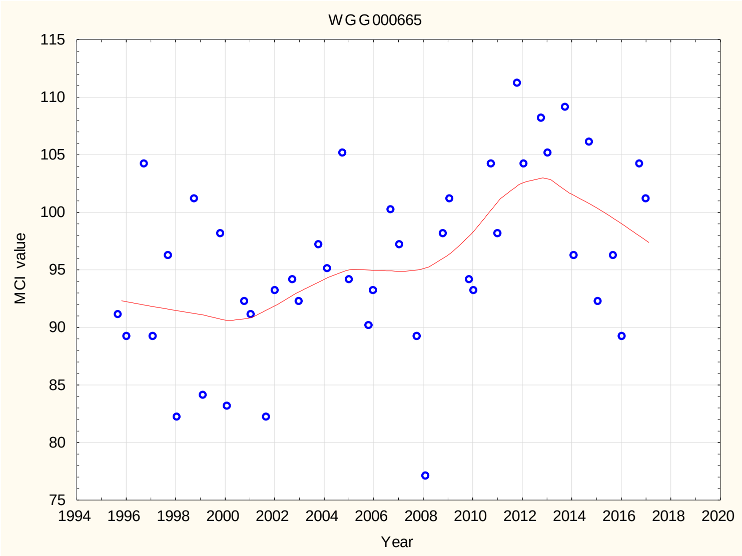
3.2.21.4.3 Predicted stream 'health'

The Waingongoro River site at Stuart Road is 29.6 km downstream of the National Park boundary at an altitude of 180 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value of 94 for this site. The historical site median, spring and summer survey scores were all not significantly different to the distance predictive value (Stark, 1998).

The median value for a ringplain river arising within the National Park at similar altitude (TRC, 2016b) was 108 units. The historic median was significantly lower than this value but the spring and summer scores were not significantly different. The REC predicted MCI value (Leathwick, et al. 2009) was 102 units. The historic median, spring and summer scores were not significantly different to the REC predictive value.

3.2.21.4.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 135). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waingongoro River at Stuart Road.



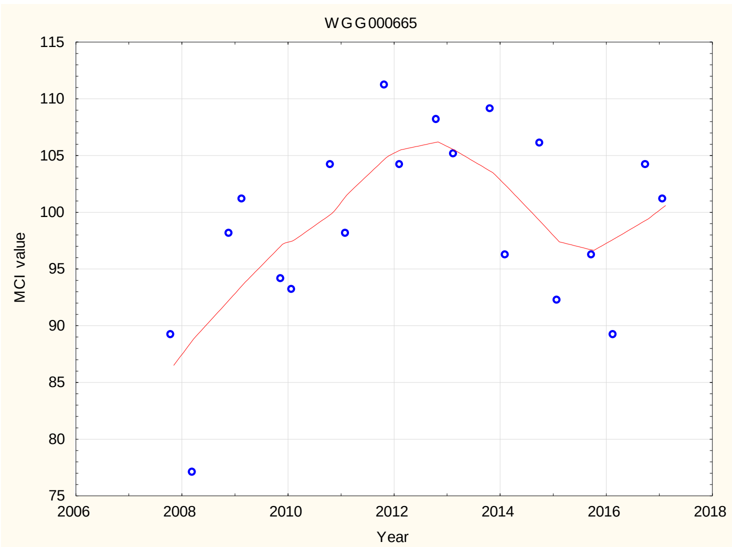
N = 44
Kendall tau = +0.327
p value = 0.002
FDR p = 0.005

Figure 135 LOWESS trend plot of MCI data at the Stuart Road site, Waingongoro River

A positive highly significant trend in MCI scores has been found over the 22 year period (FDR p <0.01 application). There has been a strong improvement in MCI scores since 2002 (coincident with summer diversion of the treated meatworks wastes discharge (at Eltham) from the river to land irrigation) and particularly most recently (since 2009) following the diversion of treated municipal Eltham wastewater out of the catchment (to the Hawera WWTP and ocean outfall). However, since 2013 scores have declined sharply. The trendline range of scores (12 units) has also been ecologically important over the 22 year period. The trendline has been indicative of 'fair' generic river health apart from a brief period where it was at 'good' generic health from 2011 to 2015 (Table 2).

3.2.21.4.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 136). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waingongoro River at Stuart Road.



N = 20
Kendall tau = +0.166
p value = 0.305
FDR p = 0.568

Figure 136 LOWESS trend plot of ten years of MCI data at the Stuart Road site, Waingongoro River

A positive but non-significant trend in MCI scores has been found over the ten year period in contrast to the highly significant trend found in the full dataset. An increase in the trendline from 2009 to 2013 was coupled with a decline from 2013to 2016. The trendline was indicative of 'fair' generic river health apart from a brief period where it was at 'good' generic health (Table 2).

3.2.21.5 SH45 site (WGG000895)

3.2.21.5.1 Taxa richness and MCI

Forty-three surveys have been undertaken in the Waingongoro River at this lower reach site at SH45 between October 1995 and March, 2016. These results are summarised in Figure 81, together with the results from the current period, and illustrated in Figure 137.

Table 98 Results of previous surveys performed in the Waingongoro River at SH45, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to March 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000895	44	13 - 25	20	73-106	95	14	97	23	88

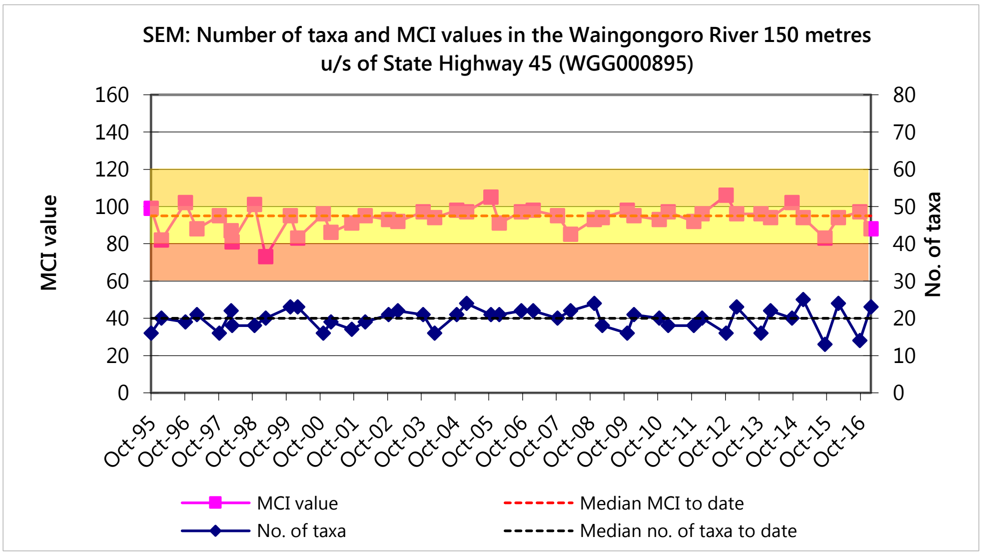


Figure 137 Numbers of taxa and MCI values in the Waingongoro River 150 m u/s of SH45

A moderate range of richnesses (13 to 25 taxa) has been found with a median richness of 20 taxa (more representative of typical richnesses in the lower reaches of ringplain streams and rivers). During the 2016-2017 period, spring (14 taxa) and summer (23 taxa) richnesses showed a large summer increase coincident with more widespread substrate periphyton cover. The spring richness was lower than the median taxa number by six taxa whereas summer richness was higher by three taxa.

MCI values have had a wide range (33 units) at this site, more typical of sites in the lower reaches of ringplain streams and rivers. The median value (95 units) has been higher than typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (97 units) and summer (88 units) scores were not significantly different to the historic median. These scores categorised this site as having 'fair' health (spring and summer) generically (Table 2). The historical median score (95 units) placed this site in the 'fair' category for generic health.

3.2.21.5.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 99.

Table 99 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waingongoro River at SH45 between 1995 and March 2016 [43 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	3			3	7		
ANNELIDA (WORMS)	Oligochaeta	1	20	12	3	35	81	A	A
	Lumbricidae	5	4			4	9		
MOLLUSCA	*Latia*	5	2			2	5		
	Potamopyrgus	4	13	17	9	39	91	A	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	3	1		4	9		
	Deleatidium	8	13	6	5	24	56	A	A
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	4			4	9		
COLEOPTERA (BEETLES)	Elmidae	6	14	12	7	33	77		A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	4			4	9		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	14	18	9	41	95		XA
	Costachorema	7	2			2	5		
	Hydrobiosis	5	16	2		18	42		
	Pycnocentrodes	5	9	18	13	40	93	A	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	7	3		10	23		
	Maoridiamesa	3	13	5		18	42		
	Orthocladiinae	2	14	7	1	22	51		A
	Polypedilum	3	1			1	2		
	Tanytarsini	3	4	1		5	12		
	Austrosimulium	3	7			7	16		

Prior to the current 2016-2017 period, 19 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and eight 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [elmid beetles and caddisfly (*Pycnocentrodes*)]; and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges)]. The spring 2016 community consisted of four historically characteristic taxa comprising a mixture of 'tolerant' and 'sensitive' taxa and had a $SQMCI_s$. score of 4.6 units indicating 'fair' health. The summer 2017 community consisted of seven characteristic taxa comprising a mixture of 'tolerant' and 'sensitive' taxa and had a $SQMCI_s$. score of 4.5 units indicating 'fair' health (Table 99) (Table 157 and Table 158).

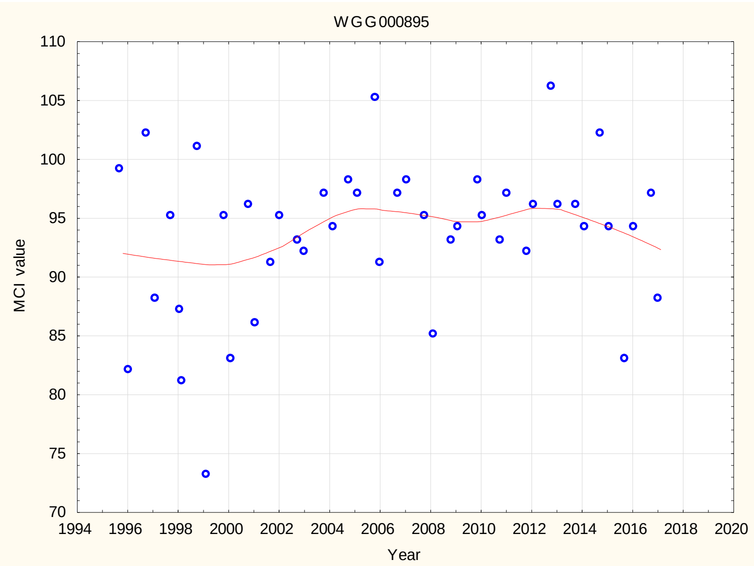
3.2.21.5.3 Predicted stream 'health'

The Waingongoro River site at SH45 is 63.0 km downstream of the National Park boundary at an altitude of 40 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value s of 85 for this site. The historical site median and summers scores were not significantly different from the distance predictive value and the spring score was significantly higher (Stark, 1998).

The median value for a ringplain river arising within the National Park at similar altitude (TRC, 2016b) was 93 units. The historical, spring and summer scores were all not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical, spring and summer scores were also not significantly different to this value (Stark, 1998).

3.2.21.5.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 138). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waingongoro River at SH45. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes.



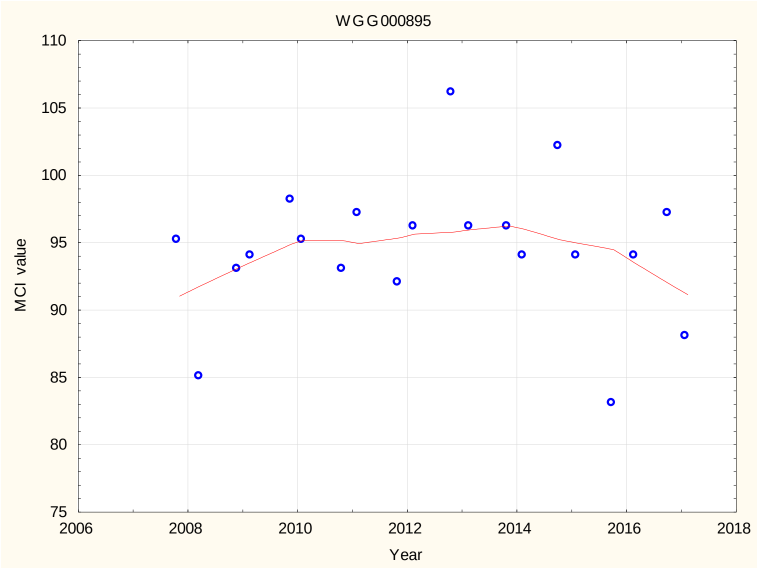
N = 45
Kendall tau = +0.113
p value = 0.275
FDR p = 0.373

Figure 138 LOWESS trend plot of MCI data for the SH45 site, Waingongoro River

A positive trend in MCI scores has been found over the 22 year period, particularly since 2000 followed by a general plateauing in trend since 2005, but the overall trend has not been statistically significant. The narrow trendline range (five units) of scores has not been ecologically important. The range of trendline scores have consistently indicated 'fair' generic river health (Table 2) throughout the period.

3.2.21.5.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 139). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on ten years of SEM results (2007-2017) from the site in the Waingongoro River at SH45.



N = 20
Kendall tau = +0.022
p value = 0.893
FDR p = 0.944

Figure 139 LOWESS trend plot of ten years of MCI data for the SH45 site, Waingongoro River

A postive, non-significant trend in MCI scores has been found over the ten year period. Generally, there appears to have been little change over the ten year period. The trendline consistently indicated 'fair' generic river health (Table 2) throughout the period.

3.2.21.6 Ohawe Beach site (WGG000995)

3.2.21.6.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Waingongoro River at this lower reach site at Ohawe Beach between October 1995 and March 2016. These results are summarised in Table 100, together with the results from the current period, and illustrated in Figure 140.

Table 100 Results of previous surveys performed in the Waingongoro River at the Ohawe Beach site, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to March 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000995	42	12 - 25	18	69-100	91	16	90	25	83

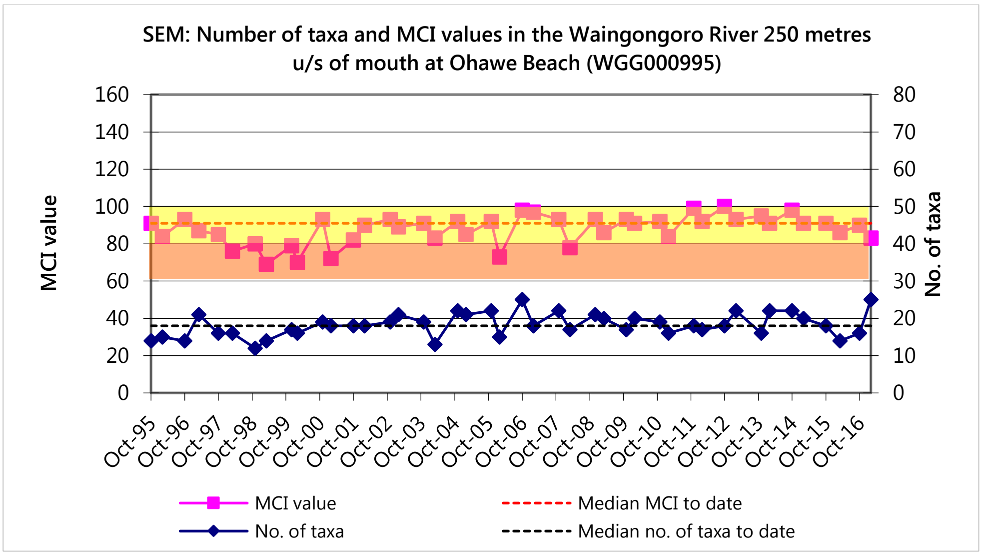


Figure 140 Numbers of taxa and MCI values in the Waingongoro River at the Ohawe Beach site

A wide range of richnesses (12 to 25 taxa) has been found, with a median richness of 18 taxa. During the 2016-2017 period, spring (16 taxa) and summer (25 taxa) richnesses were nine taxa apart with the spring richness sligntly lower than the historic richness while the summer richness was higher by seven taxa.

MCI values have had a relatively wide range (31 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been more typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2016b). The spring 2016 (90 units) and summer 2017 (83 units) scores were not significantly different to the historic median. These scores categorised this site as having 'fair' health generically in spring and summer (Table 2). The historical median score (91 units) placed this site in the 'fair' category for generic health.

3.2.21.6.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 101.

Table 101 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waingongoro River at the Ohawe Beach site between 1995 and March 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	15	9	6	30	68	VA	
	Lumbricidae	5	1			1	2		
MOLLUSCA	*Potamopyrgus*	4	22	13	1	36	82	A	XA
CRUSTACEA	*Paratya*	3	2			2	5		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	2			2	5		
	Deleatidium	8	4	5		9	20		
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	1			1	2		
COLEOPTERA (BEETLES)	Elmidae	6	14	10		24	55	A	

Taxa List		MCI	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	15	17	9	41	93		XA
	Costachorema	7	1			1	2		
	Hydrobiosis	5	3			3	7		
	Pycnocentrodes	5	12	13	12	37	84	VA	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	8			8	18		
	Maoridiamesa	3	12	13	6	31	70	A	
	Orthocladiinae	2	17	14	11	42	95	A	A
	Tanytarsini	3	7			7	16		
	Ephydridae	4	2			2	5		
	Austrosimulium	3	4			4	9		

Prior to the current 2016-2017 period, 17 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', seven 'moderately sensitive', and nine 'tolerant' taxa i.e. a lower proportion of 'sensitive' taxa and a higher proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included two 'moderately sensitive' taxa [elmid beetles and stony-cased caddisfly (*Pycnocentrodes*)]; and five 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)], but no 'highly sensitive' taxa. The spring 2016 community consisted of six characteristic taxa comprising 'sensitive' and 'tolerant' taxa with a low $SQMCI_s$ score of 3.4 units indicating 'poor' health. The summer 2017 community consisted of four characteristic taxa also comprising 'sensitive' and 'tolerant' taxa with a low $SQMCI_s$ score of 4.1 units indicating 'fair' health (Table 101) (Table 157 and Table 158).

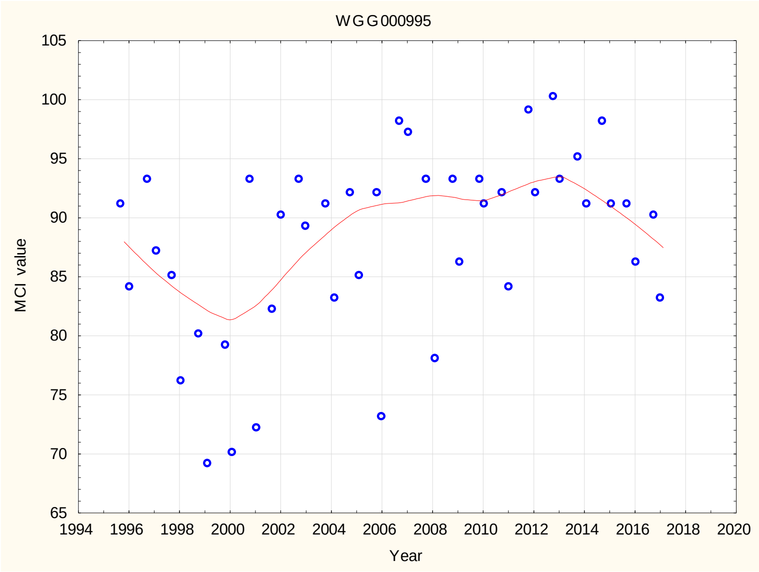
3.2.21.6.3 Predicted stream 'health'

The Waingongoro River at the Ohawe Beach site is 66.6km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams and rivers developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of and 85 for this site. The historical site median (91) is six units higher than both the predictive values. The historical (91 units), spring 2016 (90 units) and summer 2017 (83 units) scores were not significantly different to predictive value (Stark, 1998).

The median value for a ringplain river arising within the National Park at similar altitude (TRC, 2016b) was 90 units. The historical, spring and summer scores were all not significantly different to the TRC, 2016b value. The REC predicted MCI value (Leathwick, et al. 2009) was 95 units. The historical, spring and summer scores were also not significantly different to this value (Stark, 1998).

3.2.21.6.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 141). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waingongoro River at Ohawe Beach.



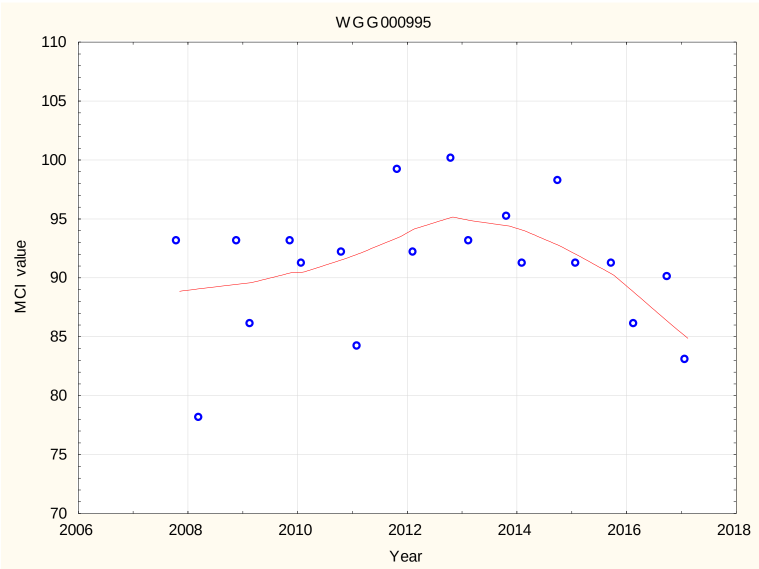
N = 44
Kendall tau = +0.245
p value = 0.019
FDR p = 0.036

Figure 141 LOWESS trend plot of MCI data at the Ohawe Beach site, Waingongoro River

There was a significant positive trend of MCI scores over the 22 year period (p < 0.05 after FDR application). There has been a marked improvement of MCI scores since 2001, which plateaued between 2006 and 2009, with a recent more gradual improvement. The trendline range of scores (11 units) has been ecologically important, mainly due to the influence of a series of low scores (<81 MCI units) between 1998 and 2001 and the elevation in scores subsequent to diversion of major mid-catchment point source discharges out of the river, particularly since 2009. Trendline scores were consistently indicative of 'fair' generic river health with the exception of the 1998 to 2001 period when generic health approached 'poor' (Table 2).

3.2.21.6.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 142). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waingongoro River at Ohawe Beach.



N = 20
Kendall tau = -0.131
p value = 0.418
FDR p = 0.645

Figure 142 LOWESS trend plot of ten years of MCI data at the Ohawe Beach site, Waingongoro River

There was a non-significant negative trend of MCI scores over the ten year period which contrasts with the significant, positive trend found in the full dataset. The discrepancy was largely the result of the large increases in MCI scores in the full dataset from 1999 to 2004 creating the positive, significant result. Though the trendline indicated a negative trend as this was not significant no real trend can be inferred. The trendline was consistently indicative of 'fair' generic river health (Table 2).

3.2.21.7 Discussion

Taxa richnesses varied considerably among sites in spring with upper sites having higher richnesses than lower sites but there was little variation among sites in summer. Generally, taxa richnesses were slightly lower than historical medians during spring which may have been due to spring freshes.

The spring surveys indicated that the macroinvertebrate community at the upper two sites were in 'very good' health, the middle two sites were in 'good' health, and the bottom two sites were in 'fair' health. The summer surveys indicated that the macroinvertebrate community at the upper two sites were again in 'very good' health, the middle two sites were in 'good' health, and the bottom two sites were in 'fair' health. The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 39 units in spring and 50 units in summer, over a river distance of 65.9 km. These seasonal falls in MCI scores were typical of most past trends, when there have been an increased summers' seasonal decline.

The time trend analysis indicated no significant trends at the upper two sites which would be expected given there relatively pristine nature. The middle two sites had significant positive trends over the full dataset indicating improvements in macroinvertebrate health but these improvements may have plateaued over the last ten years. The second lowest site had no significant trend but the lowest site had a positive significant trend. Increases in the amount of riparian fencing and planting of waterways in the catchment as well as the removal of the Eltham wastewater discharge have probably contributed to improvements in macroinvertebrate health.

3.2.22 Waiokura Stream

Two sites in this small, intensively dairy-farmed, ringplain seepage-sourced stream, were included in the SEM programme in recognition of a long-term collaborative study of the effects of best-practice dairy-farming initiatives being evaluated in five dairying catchments throughout the country (Wilcock et al, 2009). Fonterra, Kapuni lactose factory also irrigates wastewater to land in the mid reaches of this catchment. One site is located upstream of the irrigation area (in mid-catchment) and the other site approximately ten km further downstream toward the lower reaches of the stream. Some consent monitoring data have been collected from the upper site since 2003 whereas the downstream site was established for biological temporal trend purposes in the 2008-2009 period to provide an additional monitoring component of the collaborative study.

The results of spring and summer (2016-2017) surveys are summarised in Table 159 and Table 160, Appendix I.

3.2.22.1 Skeet Road site (WKR000500)

3.2.22.1.1 Taxa richness and MCI

Twenty-three surveys have been undertaken, between 2003 and February 2016, at this mid-reach, partially shaded site in the Waiokura Stream, draining open developed farmland upstream of the Fonterra, Kapuni wastewater irrigation area. These results are summarised in Table 102, together with the results from the current period, and illustrated in Figure 143.

Table 102 Results of previous surveys performed in the Waiokura Stream at Skeet Road, together with spring 2016 and summer 2017 results

Site code	SEM data (2007 to Febuary 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000500	23	18 - 29	23	88-114	99	25	111	19	97

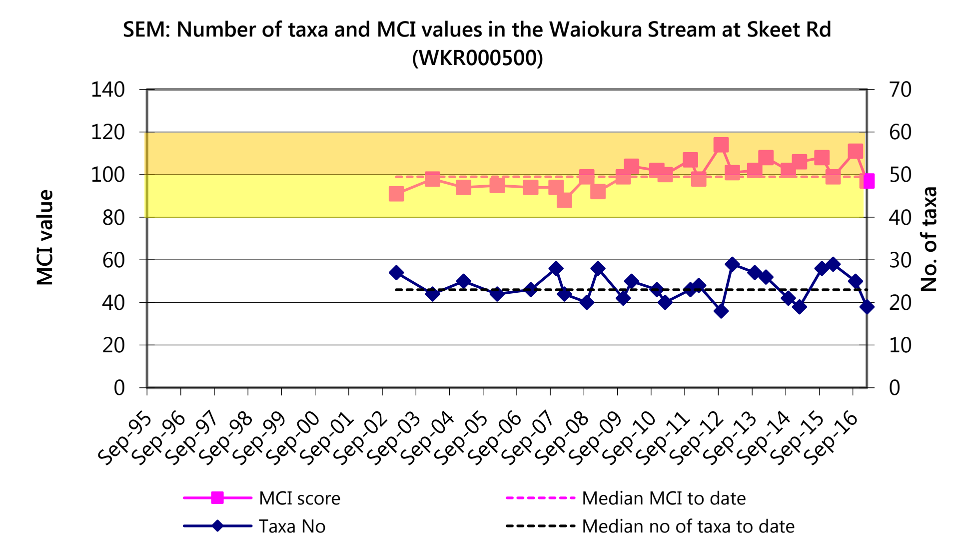


Figure 143 Numbers of taxa and MCI values in the Waiokura Stream at Skeet Road

A relatively narrow range of richnesses (18 to 29 taxa) has been found to date with a median richness of 23 taxa more typical of richnesses in the mid reaches of ringplain streams rising outside the National park boundary. During the 2016-2017 period spring (25 taxa) and summer (19 taxa) richnesses were similar to the historical median of 23 taxa.

MCI values have had a moderate range (26 units) at this site, more typical of mid reach sites on the ringplain, although the monitoring period has been relatively short to date. The historical median value (99 units) has been typical of mid-reach sites in streams rising outside the National Park elsewhere on the ringplain (TRC, 2016b). The spring 2016 (111 units) score was significantly higher than the historical median and the summer 2017 (97 units) scores was not significantly different to the historical median. The scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 2). The historical median score (99 units) placed this site in the 'fair' category for generic health.

3.2.22.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 103.

Table 103 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waiokura Stream at Skeet Road, between 2003 and February 2016 [23 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	1			1	4		
ANNELIDA (WORMS)	Oligochaeta	1	9	2		11	44		A
MOLLUSCA	*Potamopyrgus*	4	6	1		7	28		
CRUSTACEA	Ostracoda	1							A
	Paracalliope	5	1			1	4		A
	Paraleptamphopidae	5	2			2	8		
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	2			2	8	VA	VA
	Coloburiscus	7	2	16	7	25	100		
	Deleatidium	8	7	1		8	32		
	Zephlebia group	7	7	4	1	12	48		A
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	8	5		13	52		
COLEOPTERA (BEETLES)	Elmidae	6	4			4	16	VA	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	4	12	9	25	100	A	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	16			16	64	A	
	Costachorema	7	5	13	6	24	96		
	Hydrobiosis	5	1			1	4		
	Confluens	5	3	1		4	16		
	Helicopsyche	10	1			1	4		
	Pycnocentria	7	1			1	4		
	Pycnocentrodes	5	1			1	4		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	7	2		9	36		
	Maoridiamesa	3	1			1	4		
	Orthocladiinae	2	1	2		3	12		
	Tanytarsini	3	3	4		7	28	A	
	Austrosimulium	3	2			2	8		

Prior to the current 2016-2017 period 22 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', 13 'moderately sensitive' and eight 'tolerant' taxa i.e. a moderately high proportion (64%) of 'sensitive' taxa as would be expected in the mid-reaches of a ringplain stream rising outside the National Park.

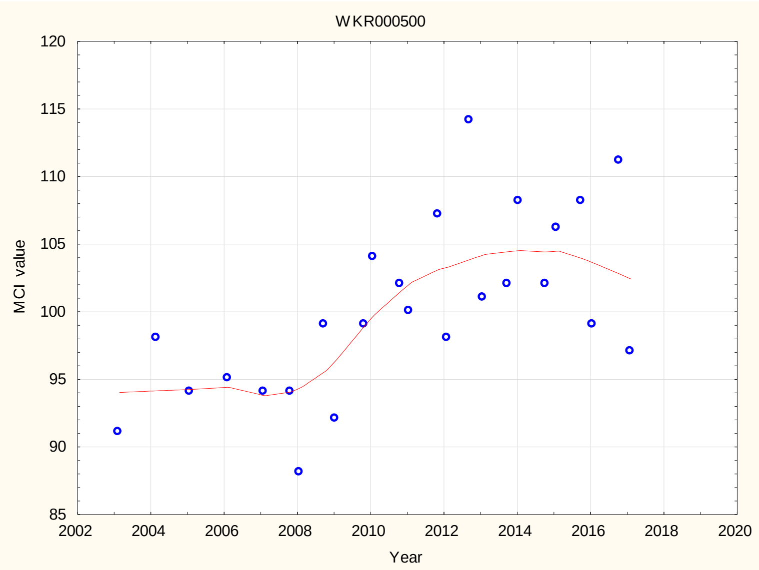
Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; three 'moderately sensitive' taxa [mayfly (*Austroclima*), elmid beetles, and dobsonfly (*Archichauliodes*)]; and one 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche)*]. Two of the 'moderately sensitive' and one of the 'tolerant' taxa have been dominant on all survey occasions (Table 103).The spring 2016 community consisted of five characteristic taxa comprising 'sensitive' and 'tolerant' taxa with a high $SQMCI_s$ score of 6.0 units indicating 'very good' health. The summer 2017 community consisted of six characteristic taxa comprising 'sensitive' and 'tolerant' taxa with a moderate $SQMCI_s$ score of 5.5 units indicating 'good' health (Table 103, Table 159 and Table 160).

3.2.22.1.3 Predicted stream 'health'

The Waiokura Stream rises below the National Park boundary and the site at Skeet Road is in the mid-reaches at an altitude of 150 m asl. The median MCI score for a ringplain stream arising outside the National Park at similar altitude was 97 units (TRC, 2016b). The REC predicted MCI value (Leathwick, et al. 2009) was also 97 units. The spring score was a significant 14 units higher, while the summer score and historical median were not significantly higher than the two predictive values (Stark, 1998).

3.2.22.1.4 Temporal trends in 2002 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 144). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 15 years of SEM results (2002-2017) from the site in the Waiokura Stream at the site on Skeet Road.



N = 25
Kendall tau = +0.492
p level <0.001
FDR p = 0.002

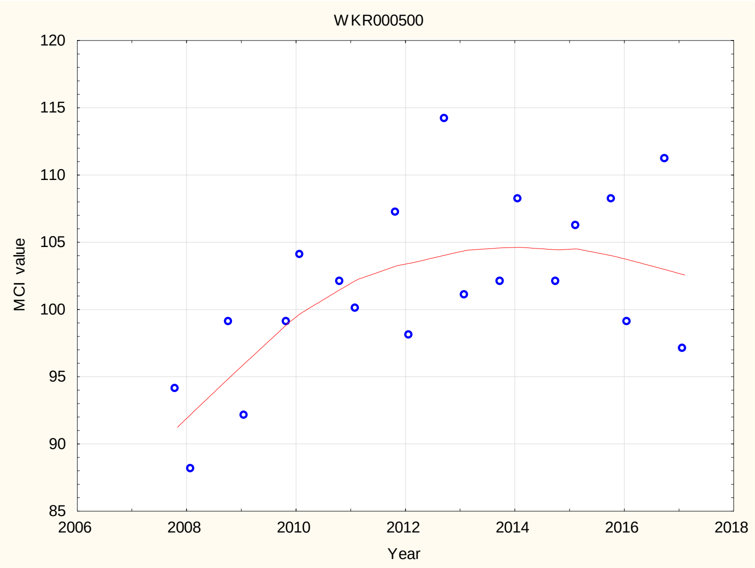
Figure 144 LOWESS trend plot of MCI data in the Waiokura Stream at the Skeet Road site

Since 2009 there has been relatively strong temporal improvement in MCI scores at this site, with a minor decrease since 2014. The trendline range of MCI scores (ten units) has bordered on ecological importance. Increases in scores may have been related to improvements in farming practices and/or wastes disposal in the rural catchment between the stream's seepage sources (below the National Park) and mid reaches at Skeet Road, although the shorter duration and less frequent initial monitoring must be noted.

Trendline MCI scores have been indicative of 'fair' generic stream health (Table 2) for the first eight years of the period improving to the 'good' health category over the most recent seven years.

3.2.22.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 145). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the most recent ten years of SEM results (2007-2017) from the site in the Waiokura Stream at the site on Skeet Road.



N = 19
Kendall tau = +0.381
p level =0.019
FDR p = 0.277

Figure 145 LOWESS trend plot of MCI data in the Waiokura Stream at the Skeet Road site

The trendline over the ten year period was positive but non-significant after FDR was applied, despite some moderate improvements in scores over the first seven years, which was probably due to the slight decline that has occurred in the last three years.

3.2.22.2 Manaia golf course site (WKR000700)

3.2.22.2.1 Taxa richness and MCI

Seventeen surveys have been undertaken at this more recently established lower reach site in the Waiokura Stream at Manaia between 2007 and February 2016. These results are summarised in Table 104 together with the results from the current period, and illustrated in Figure 146.

Table 104 Results of previous surveys performed at Waiokura Stream at Manaia golf course, together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to Febuary 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000700	17	16-27	24	92-109	96	23	98	19	94

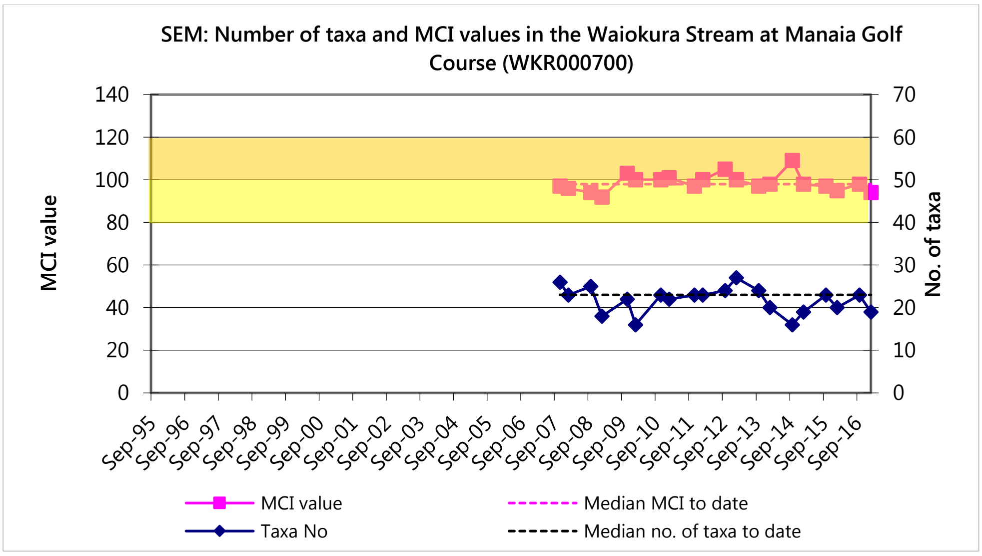


Figure 146 Numbers of taxa and MCI values in the Waiokura Stream at Manaia Golf course

A moderate range of richnesses (16 to 27 taxa) has been found, with a median richness of 23 taxa (more representative of typical richnesses for the lower reaches of ringplain streams rising outside the National Park boundary). During the 2016-2017 period spring (23 taxa) and summer (19 taxa) richnesses were relatively similar but up to three taxa fewer than this median richness.

MCI values have had a narrow range (17 units) at this site partly due to the short duration of the monitoring period to date. The median value (98 units) has been slightly higher than typical of similar lower reach sites elsewhere on the ringplain (TRC, 2016b). The spring, 2016 (98 units) and summer, 2017 (94 units) scores were not significantly different to the historical median score. These scores categorised this site as having 'fair' (spring and summer) health generically (Table 2). The historical median score (98 units) placed this site in the 'fair' category for generic health.

3.2.22.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site for the relatively short monitoring period prior to the 2016-2017 surveys are listed in Table 105.

Table 105 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waiokura Stream at the Manaia golf course, between 2007 and February 2016 [18 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMATODA	Nematoda	3	1			1	6		
ANNELIDA (WORMS)	Oligochaeta	1	12	2		14	78		A
MOLLUSCA	*Potamopyrgus*	4	5	1		6	33		
CRUSTACEA	*Paracalliope*	5	1			1	6		A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	1	14	3	18	100	VA	
	Coloburiscus	7	5	6		11	61	A	
	Deleatidium	8	1	1		2	11		
	Zephlebia group	7	5	11	2	18	100	VA	VA

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	3			3	17	A	
COLEOPTERA (BEETLES)	Elmidae	6	3	13	2	18	100	A	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	15			15	83	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	5	8	2	15	83	A	VA
	Hydrobiosis	5	1			1	6		
	Pycnocentria	7	1			1	6		
	Pycnocentrodes	5	3	1		4	22		

Prior to the current 2016-2017 period, 15 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and four 'tolerant' taxa i.e. a higher proportion of 'sensitive' taxa than might be expected in the lower reaches of a ringplain stream, but coincident with the riparian cover provided within the Manaia golf course reach.

Predominant taxa have included five 'moderately sensitive' taxa [mayflies (*Austroclima*, *Zephlebia* group, and *Coloburiscus*), elmid beetles and dobsonfly (*Archichauliodes*)] and two 'tolerant' taxa [oligochaete worms and net-building caddisfly (*Hydropsyche-Aoteapsyche*)].

The spring 2016 community consisted of seven characteristic taxa comprising mostly 'sensitive' taxa with a high $SQMCI_s$ score of 6.4 units indicating 'very good' health. The summer 2017 community consisted of six characteristic taxa comprising 'sensitive' and 'tolerant' taxa with a moderate $SQMCI_s$ score of 5.2 units indicating 'good' health (Table 103, Table 159 and Table 160).

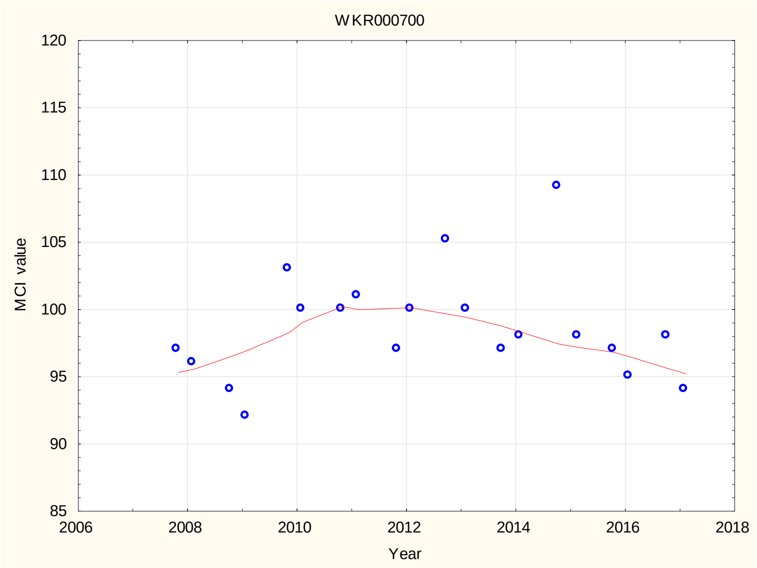
3.2.22.2.3 Predicted stream 'health'

The Waiokura Stream rises below the National Park boundary and the site at the Manaia golf course is in the lower reaches at an altitude of 70 m asl.

The median MCI score for a ringplain stream arising outside the National Park at similar altitude was 95 units (TRC, 2016b). The REC predicted MCI value for this site (Leathwick, et al. 2009) was 95 units. The historical median, spring and summer scores were not significantly different from the median MCI score and REC predictive value.

3.2.22.2.4 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 147). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the most recent ten years of SEM results (2007-2017) from the site in the Waiokura Stream at Manaia golf course.



N = 20
Kendall tau = -0.033
p level =0.839
FDR p = 0.944

Figure 147 LOWESS trend plot of MCI data in the Waiokura Stream for the Manaia golf course

A positive, non-significant trend of improvement in MCI scores since 2009 to that found at the upstream site (at Skeet Road) was identified at this site at the Manaia golf course (although more stable since 2010). The relatively narrow range of scores (five units) has no ecological importance to date.

The trendline range indicated 'fair' generic stream health (Table 1) for two years of the monitoring period, improved to 'good' stream health for about three years before returning to 'fair' stream health most recently.

3.2.22.3 Discussion

Taxa richnesses for both surveys were moderate at both sites and within previous recorded ranges.

The spring survey indicated that the upper macroinvertebrate community was in 'good' health and was in better than normal condition while the lower macroinvertebrate community was in 'fair' health and in typical condition. The summer survey indicated that both macroinvertebrate communities were in 'fair' health and in typical condition. The MCI score decreased by a significant 14 units in spring and decreased by three units in summer in a downstream direction over the 9.7 km reach, between the more open farmland mid-reach site (Skeet Road) and the lower reach Manaia golf course site. This was despite some improvement in habitat provided by patches of riparian vegetation cover through the golf course.

The time trend analysis indicated no significant trends after FDR adjustment at both sites. The upper site had a positive trend that was significant before FDR adjustment but the lower site had a very weak negative trend. The results suggest little change in the health of the macroinvertebrate communities is occurring at both sites.

3.2.23 Waiongana Stream

The Waiongana Stream has a source within Egmont National Park and flows in an easterly direction with a mouth just east of Bell Block. There are two sites on the stream used for SEM surveys. No spring survey was able to be completed due to persistently high flows. The results for the summer 2017 survey are presented in Table 106.

3.2.23.1.1 State Highway 3a site (WGA000260)

3.2.23.1.2 Taxa richness and MCI

Forty-three surveys have been undertaken at this mid reach site in the Waiongana Stream between October 1995 and February 2016. These results are summarised in Table 106, together with the results from the current period, and illustrated in Figure 148.

Table 106 Results of previous surveys performed in the Waiongana Stream at SH3A together with the summer 2017 result

Site code	SEM data (1995 to February 2016)						2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values			Feb 2017	
		Range	Median	Range	Median		Taxa no	MCI
WGA000260	43	12-30	24	82-112	96		21	100

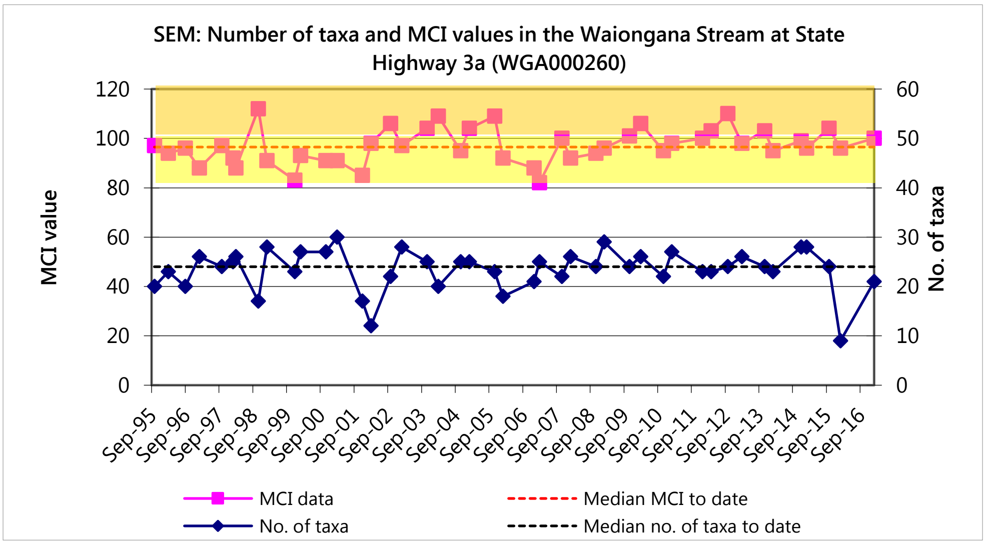


Figure 148 Numbers of taxa and MCI values in the Waiongana Stream at State Highway 3A

A wide range of richnesses (12 to 30 taxa) has been found; with a median richness of 24 taxa (more representative of typical richnesses in the mid-reaches of ringplain streams and rivers. During the 2016-2017 period, the summer (21 taxa) richness was similar to the historical median (24 taxa).

MCI values have also had a relatively wide range (30 units) at this site, relatively typical of a site in the mid reaches of a ringplain stream. The median value (96 units) also has been typical of mid-reach sites elsewhere on the ringplain (TRC, 2016b). The summer 2017 (100 units) survey was not significantly different to the historical median. The score categorised this site as having 'good' (summer) health generically (Table 2). The historical median score (96 units) placed this site in the 'fair' category.

3.2.23.1.3 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 107.

Table 107 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waiongana Stream at SH3A between 1995 and February 2016 [43 surveys], and by summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Surveys Summer 2017
NEMERTEA	Nemertea	3	2			2	5	
ANNELIDA (WORMS)	Oligochaeta	1	20	1		21	49	
MOLLUSCA	*Potamopyrgus*	4	15	4		19	44	
CRUSTACEA	*Paracalliope*	5	1			1	2	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	4			4	9	
	Coloburiscus	7	4	1		5	12	
	Deleatidium	8	8	11	3	22	51	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	1			1	2	
COLEOPTERA (BEETLES)	Elmidae	6	17	14	3	34	79	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	13			13	30	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	17	10		27	63	A
	Costachorema	7	12	1		13	30	
	Hydrobiosis	5	18	2		20	47	
	Neurochorema	6	3			3	7	
	Beraeoptera	8	1			1	2	
	Oxyethira	2	8	1		9	21	
	Pycnocentrodes	5	12	2		14	33	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	20	15	1	36	84	A
	Maoridiamesa	3	15	12	2	29	67	A
	Orthocladiinae	2	15	12	10	37	86	A
	Tanytarsini	3	12	3	1	16	37	
	Empididae	3	7			7	16	
	Muscidae	3	6			6	14	
	Austrosimulium	3	3			3	7	

Prior to the current 2016-2017 period, 22 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and eleven 'tolerant' taxa i.e. a relatively even balance of 'sensitive' and 'tolerant' taxa as would be expected in the mid-reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)], two 'moderately sensitive' taxa [elmid beetles and cranefly (*Aphrophila*)], and four 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)].

The summer 2017 community consisted of seven characteristic taxa comprising 'sensitive' and 'tolerant' taxa with a moderate $SQMCI_s$ score of 5.9 units indicating 'good' health (Table 107 and Table 161).

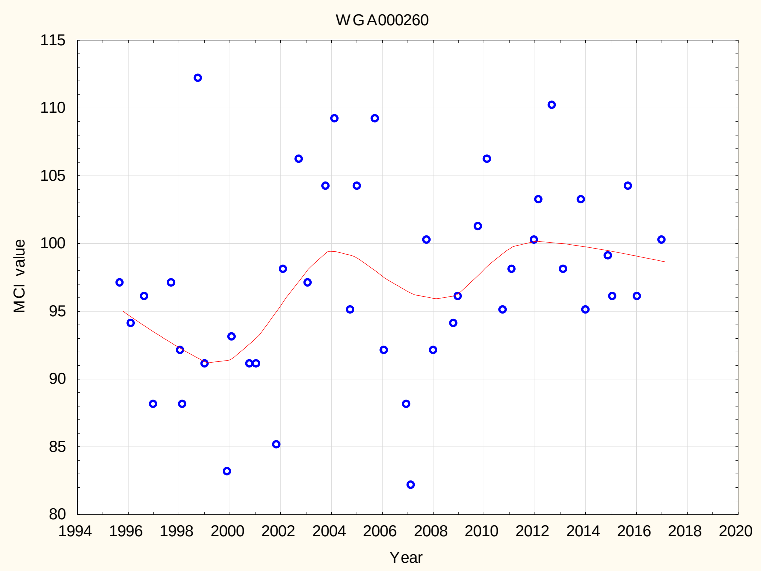
3.2.23.1.4 Predicted stream 'health'

The Waiongana Stream site at SH3a is 16.1 km downstream of the National Park boundary at an altitude of 140 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 100 for this site. The historical site median (96 units) and summer scores (100 units) were not significantly different from this value.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 102 units. The historical site median and summer scores was not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 99 units. The historical site median and summer scores were also not significantly different to this value.

3.2.23.1.5 Temporal trends in 1995 to 2016 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 149). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on 22 years of SEM results (1995-2017) from the site in the Waiongana Stream at SH3A.



N = 44
Kendall tau = +0.239
p level = 0.022
FDR p = 0.041

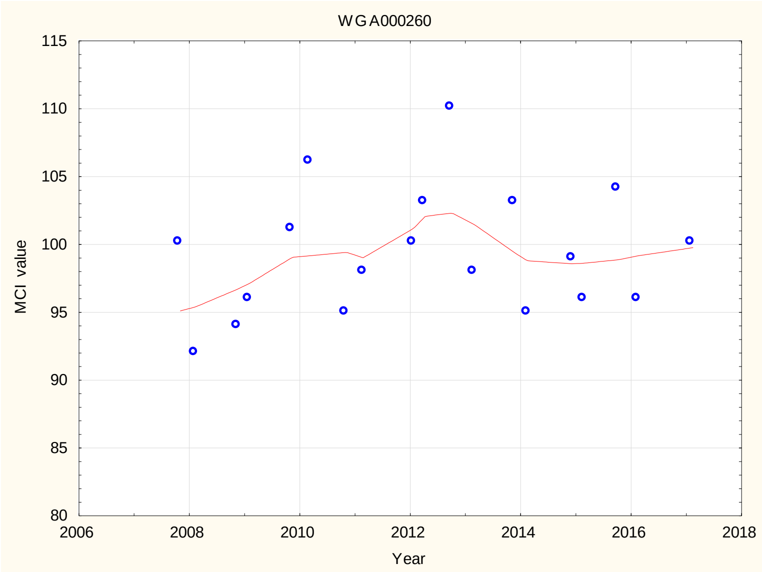
Figure 149 LOWESS trend plot of MCI data at the SH3A site

There has been a significant positive trend in the MCI scores (FDR at $p < 0.05$) with a steady improvement in scores between 2001 and 2004 followed by a decline in scores until 2008, and another steady increase more recently. This site's trendline had a range of nine units indicative of marginal ecologically important variability over the period.

Overall, the trendline was indicative of 'fair' generic stream health (Table 2) for the majority of the period, improving toward 'good' 'health' briefly in 2011 and 2012.

3.2.23.1.6 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 150). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on ten years of SEM results (2007-2017) from the site in the Waiongana Stream at SH3A.



N = 20
Kendall tau = +0.168
p level = 0.314
FDR p = 0.568

Figure 150 LOWESS trend plot of ten years of MCI data at the SH3A site, Waiongana Stream

There has been a non-significant positive trend in the MCI scores (FDR at p >0.05) with a steady improvement in scores between 2007 and 2004 followed by a slight decline in scores from 2013. The lack of a positive significant result in contrast with the full dataset was probably due to the large gains in macroinvertebrate health that occurred during the late 1990s not being incorporated into the analysis. Overall, the trendline range was indicative of 'fair' generic stream health (Table 2) for the majority of the period, improving toward 'good' 'health' briefly between 2011 and 2013.

3.2.23.2 Devon Road site (WGA000450)

3.2.23.2.1 Taxa richness and MCI

Forty-ytwo surveys have been undertaken at this lower reach site at SH45 in the Waiongana Stream between October 1995 and February 2016. These results are summarised in Table 108, together with the results from the current period, and illustrated in Figure 151.

Table 108 Results of previous surveys performed in the Waiongana Stream at Devon Road together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to February 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
WGA000450	42	12-29	22	72-102	90	18	88

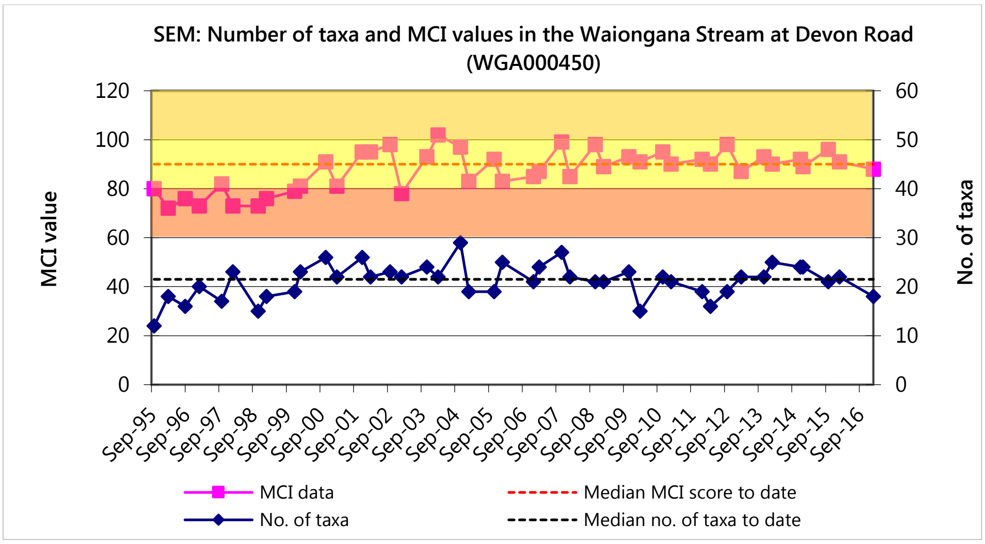


Figure 151 Numbers of taxa and MCI values in the Waiongana Stream at Devon Road

A wide range of richness (12 to 29 taxa) has been found with a median richness of 22 taxa, more representative of typical richnesses in ringplain streams and rivers in the lower reaches. During the 2016-2017 period, summer (18 taxa) richnes was four taxa lower than the median taxa number.

MCI scores have had a relatively wide range (30 units) at this site typical of sites in the lower reaches of ringplain streams. The median value (90 units) also has been typical of lower reach sites elsewhere on the ringplain (TRC, 2016b), with summer 2017 (88 units) scores within the range typical for such a site and the same as the historical median score. These scores categorized this site as having 'fair' (summer) health generically (Table 2). The historical median score (90 units) placed this site in the 'fair' category for generic health.

3.2.23.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 109.

Table 109 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waiongana Stream at Devon Road between 1995 and February 2016 [43 surveys], and by the summer 2017 survey

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
NEMERTEA	Nemertea	3	3			3	7	
ANNELIDA (WORMS)	Oligochaeta	1	20	12	1	33	79	
MOLLUSCA	*Ferrissia*	3	1			1	2	
	Latia	5	2			2	5	
	Potamopyrgus	4	10	8	9	27	64	
CRUSTACEA	*Paracalliope*	5	2			2	5	
	Paratya	3	1			1	2	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	4			4	10	
	Deleatidium	8	6	3		9	21	

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	2			2	5	
COLEOPTERA (BEETLES)	Elmidae	6	9	14		23	55	
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	9			9	21	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	9	14	5	28	67	
	Costachorema	7	2			2	5	
	Hydrobiosis	5	15	2		17	40	
	Neurochorema	6	4			4	10	
	Oxyethira	2	7	1		8	19	
	Pycnocentrodes	5	10	8	2	20	48	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	17	2		19	45	
	Maoridiamesa	3	13	5		18	43	
	Orthocladiinae	2	23	11	2	36	86	A
	Tanytarsini	3	10	5		15	36	
	Empididae	3	1			1	2	
	Muscidae	3	4			4	10	
	Austrosimulium	3	6			6	14	

Prior to the current 2016-2017 period, 25 taxa have characterised the community at this site on occasions. These have comprised one ‘highly sensitive’, 11 ‘moderately sensitive’, and 13 ‘tolerant’ taxa i.e. a majority of ‘tolerant’ taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included no ‘highly sensitive’ taxa; one ‘moderately sensitive’ taxon [elmid beetles]; and four ‘tolerant’ taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges].

The summer 2017 community consisted of one characteristic taxon comprising a ‘tolerant’ taxon with a moderate $SQMCI_s$ score of 4.7 units indicating ‘fair’ health (Table 108 and Table 161).

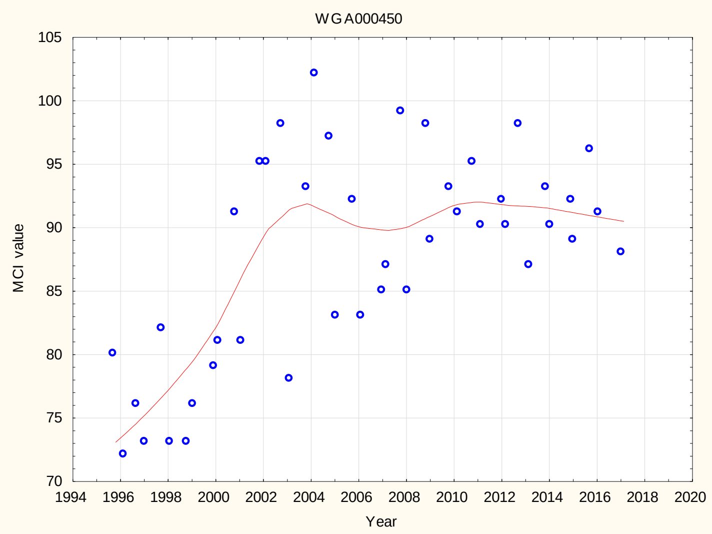
3.2.23.2.3 Predicted stream ‘health’

The Waiongana Stream at Devon Road is 31.2 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 93 for this site. The historical site median (96 units) and summer scores (100 units) were not significantly different from this value.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 90 units. The historical site median and summer scores was not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 88 units. The historical site median and summer scores were also not significantly different to this value.

3.2.23.2.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 152). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waiongana Stream at Devon Road.



N = 43
Kendall tau = + 0.371
p level < 0.001
FDR p = 0.002

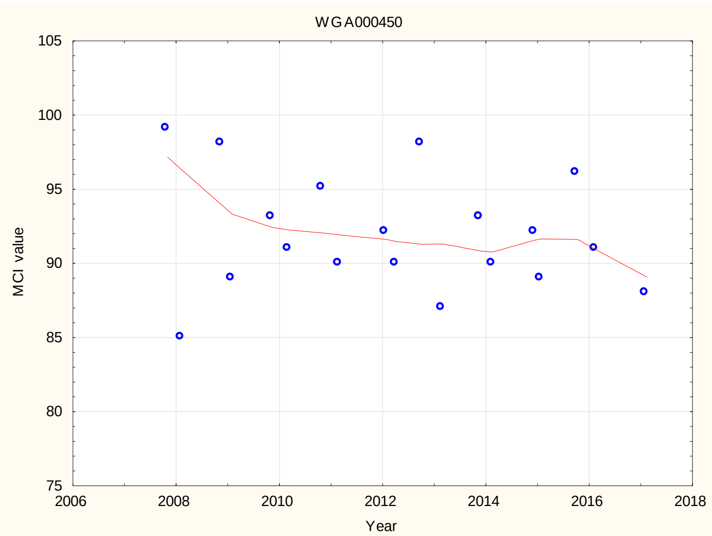
Figure 152 LOWESS trend plot of MCI data at the Devon Road site

MCI scores at this site have shown a statistically significant (FDR p <0.01) strong temporal improvement over the period, despite some relatively low scores between 2003 and 2008. However, the more recent scores remain well above those recorded over the first five years of the period. The trendline has varied over an ecologically important range of 18 units. Improvement has been coincident with a reduction in consented NPDC water abstraction and tighter control of an upstream piggery's waste loadings into the stream. This trend of improvement in stream 'health' at this site is much more pronounced than the trend at the site some 15 km upstream, indicating that activities in the catchment between these two sites have had a significant influence on the bottom site.

Overall the trendline has indicated significant improvement in generic stream 'health' (Table 2) from consistently 'poor' prior to 2000 to 'fair' where it has remained over the last 16 years.

3.2.23.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 153). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waiongana Stream at Devon Road.



N = 19
Kendall tau =- 0.162
p level = 0.333
FDR p = 0.583

Figure 153 LOWESS trend plot of ten years of MCI data at the Devon Road site

MCI scores at this site have shown a non-statistically significant (FDR p >0.05) minor decline. This contrasts with the highly significant improvements found using the full dataset suggesting improvements have plateaued at the site. Overall, the trendline has indicated 'fair' generic stream 'health' (Table 2).

3.2.23.3 Discussion

Taxa richnesses for both sites were moderate and within previous recorded ranges.

The summer survey indicated that the mid-reach (SH3a) site was in 'good' health while the lower reach (Devon Road) site was in 'fair' health which was typical for both sites. MCI score typically decreased in a downstream direction in summer (by 12 units), over a stream distance of 15.1 km downstream from the National Park boundary. The decrease in score was proably attributable to diffuse and point source discharges that have caused nutrient enrichment.

The time trend analysis indicated no significant trends after FDR adjustment at both sites. The upper site had a positive trend that was significant before FDR adjustment but the lower site had a very weak negative trend. The results suggest little change in the health of the macroinvertebrate communities is occurring at both sites.

3.2.24 Waitara River

The Waitara River is Taranaki's largest river with significant catchment areas in both the eastern hill country and on the eastern side of the Taranaki ringplain. Two SEM sites are situated on the mainstem of the Waitara River. Results found by the 2016-2017 surveys are presented in Table 162 and Table 163, Appendix I.

3.2.24.1 Autawa Road site (WTR000540)

3.2.24.1.1 Taxa richness and MCI

This is the second set of surveys at this recently established middle reach site in the Waitara River where surveys have been carried out between October 2015 and February 2016. These results are summarised in Table 110 and illustrated in Figure 154.

Table 110 Results of the spring 2016 and summer 2017 surveys performed in the Waitara River at Autawa Road

Site code	SEM data (2015 to Febuary 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WTR000540	2	26	26	98-99	99	26	95	19	102

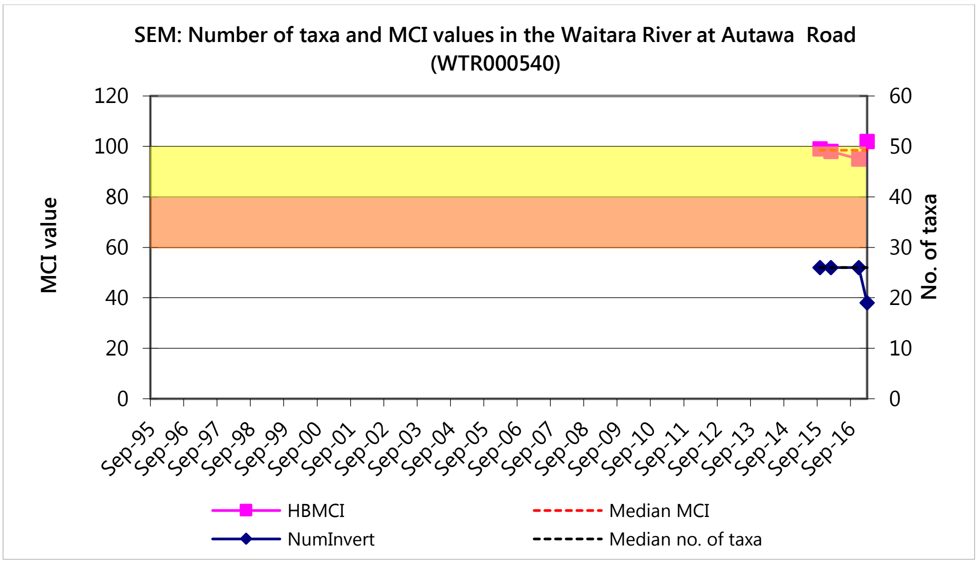


Figure 154 Numbers of taxa and MCI values in the Waitara River upstream of Methanex at Mamaku Road

No variation in taxa richness (26 taxa) has been found with a median richness of 26 taxa. A moderately high richness of 26 taxa was recorded for the spring survey with a lower but still moderate taxa richness of 19 taxa recorded for the summer survey.

MCI values have had a narrow range (one MCI units) at this site suggesting little seasonal variation. The median value (99 units) was slightly higher than typical lower reach sites elsewhere although lower reach sites in large hill country rivers tended to have had lower MCI values (TRC, 2016b). The spring 2016 score (95 units) and summer 2017 score (102 units) were not significantly different from the historic median. These scores categorised this site as having 'fair' health generically (Table 2) in spring and 'good' health in summer.

3.2.24.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site for the 2016-2017 period are listed in Table 39.

Table 111 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waitara River at Mamaku Road by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	1			1	50	A	
MOLLUSCA	*Potamopyrgus*	4	1			1	50	XA	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	1			1	50	A	
	Deleatidium	8			1	1	50	A	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	1			1	50		
COLEOPTERA (BEETLES)	Elmidae	6	2			2	100	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4		1		1	50		

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
	Pycnocentrodes	5	1			1	50	A	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	1	1		2	100		A
	Orthocladiinae	2	1			1	50		
	Tanytarsini	3	1			1	50		

There have been 11 characteristic taxa previously recorded at the site with only one 'highly sensitive' taxon recorded, the mayfly *Deleatidium*. The spring 2016 community consisted of six characteristic taxa comprising mostly 'tolerant' taxa with a moderate $SQMCI_s$ score of 4.3 units indicating 'fair' health. The summer 2017 community consisted of four characteristic taxa comprising mostly 'tolerant' taxa with a moderate $SQMCI_s$ score of 4.8 units indicating 'fair' health (Table 111 and Table 162 and Table 163).

3.2.24.2.1 Predicted stream 'health'

The Waitara River site at Autawa Road, at an altitude of 100 m asl, is in the middle reaches the river draining a catchment comprised of eastern hill country.

The median value for ringplain streams of similar altitude for eastern hill country streams (TRC, 2016b) was 93 units. The spring and summer scores were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 110 units. The historical median and spring, but not the summer score, was significantly lower than this value.

3.2.24.2.2 Temporal trends

Insufficient data exists to perform a time trend analysis on the data.

3.2.24.3 Mamaku Road site (WTR000850)

3.2.24.3.1 Taxa richness and MCI

Forty-two surveys have been undertaken at this lower reach site in the Waitara River between November 1995 and February 2016. These results are summarised in Table 112, together with the results from the current period, and illustrated in Figure 155.

Table 112 Results of previous surveys performed in the Waitara River at Mamaku Road together with spring 2016 and summer 2017 results

Site code	SEM data (1995 to Febuary 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WTR000850	42	9-32	18	64-107	86	14	96	16	85

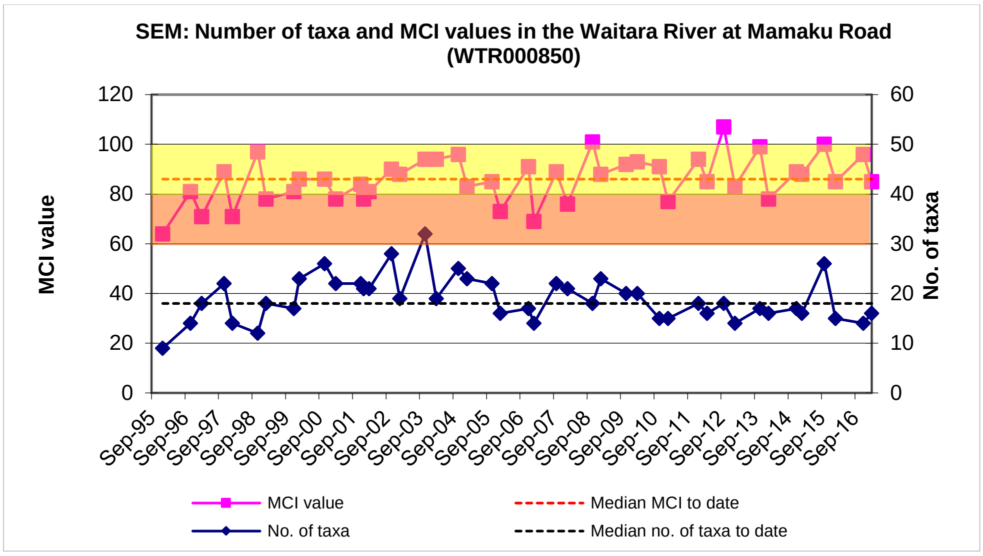


Figure 155 Numbers of taxa and MCI values in the Waitara River upstream of Methanex at Mamaku Road

A very wide range of richnesses (9 to 32 taxa) has been found with a moderate median richness of 19 taxa (more representative of typical richnesses in the lower reaches of streams and rivers (TRC, 2016b)). During the 2016-2017 period, spring and summer richnesses (14 and 16 taxa respectively) were slightly lower than this median richness.

MCI values have had a very wide range (43 units) at this site which has not been unusual for sites in the lower reaches of large rivers. The historical median value (86 units) has also been typical of lower reach sites elsewhere although lower reach sites in large hill country rivers tended to have had lower MCI values (TRC, 2016b). The spring 2016 (96 units) and summer 2017 (85 units) scores were not significantly different to the historical median. These scores categorised this site as having 'fair' health during the spring and summer surveys (Table 2). The historical median score (86 units) placed this site in the 'fair' category.

3.2.24.4 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 113.

Table 113 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waitara River at Mamaku Road between 1995 and February 2016 [42 surveys], and by the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
NEMERTEA	Nemertea	3	2			2	5		
ANNELIDA (WORMS)	Oligochaeta	1	11	8	7	26	62		
	Branchiura	1	1			1	2		
	Polychaeta	3	2			2	5		
MOLLUSCA	*Latia*	5	8	2		10	24		
	Potamopyrgus	4	11	6	2	19	45		
CRUSTACEA	Tanaidacea	3	1			1	2		

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
	Paratya	3	11	2		13	31		
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	11	5		15	36	A	
COLEOPTERA (BEETLES)	Elmidae	6	1			1	2		
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	11	14	2	25	60	A	XA
	Oxyethira	2	10	1	1	12	29		
	Pycnocentrodes	5	4			4	10		
DIPTERA (TRUE FLIES)	*Aphrophila*	5	14	2		16	36		A
	Maoridiamesa	3	4			4	10		
	Orthocladiinae	2	17	11	4	32	76	A	A
	Tanytarsini	3	9	3		12	29		A
	Austrosimulium	3	1			1	2		

Prior to the current 2016-2017 period, 18 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', four 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain/hill-country river. Predominant taxa have included only three 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche- Aoteapsyche*), and orthoclad midges].

The spring 2016 community consisted of three characteristic taxa comprising two 'tolerant' and one 'sensitive' taxa with a moderate $SQMCI_s$ score of 4.7 units indicating 'fair' health. The summer 2017 community consisted of four characteristic taxa comprising mostly 'tolerant' taxa with a $SQMCI_s$ score of 4.0 units indicating 'fair' health (Table 113 and Table 162 and Table 163).

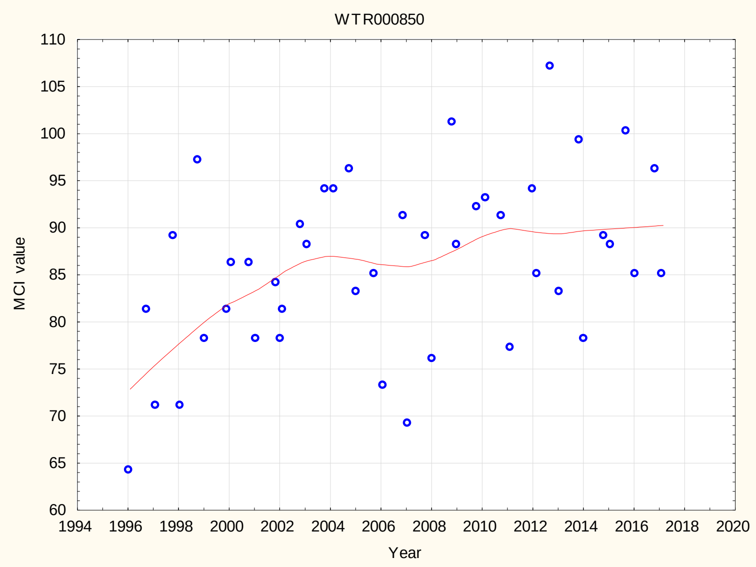
3.2.24.4.1 Predicted stream 'health'

The Waitara River site at Mamaku Road, at an altitude of 15 m asl, is in the lower reaches of a river draining a catchment comprised of both hill country and ringplain sub-catchments.

The median value for ringplain streams of similar altitude arising in eastern hill country (TRC, 2016b) was 78 units. The historical site median and summer scores were not significantly different to this value but the spring value was significantly higher (18 units). The REC predicted MCI value (Leathwick, et al. 2009) was 98 units. The historical site median and summer scores were significantly lower than this value (by 12 and 13 units respectively) but the spring score was not significantly different.

3.2.24.5 Temporal trends in 1996 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 156). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 20 years of SEM results (1996-2017) from the site in the Waitara River at Mamaku Road.



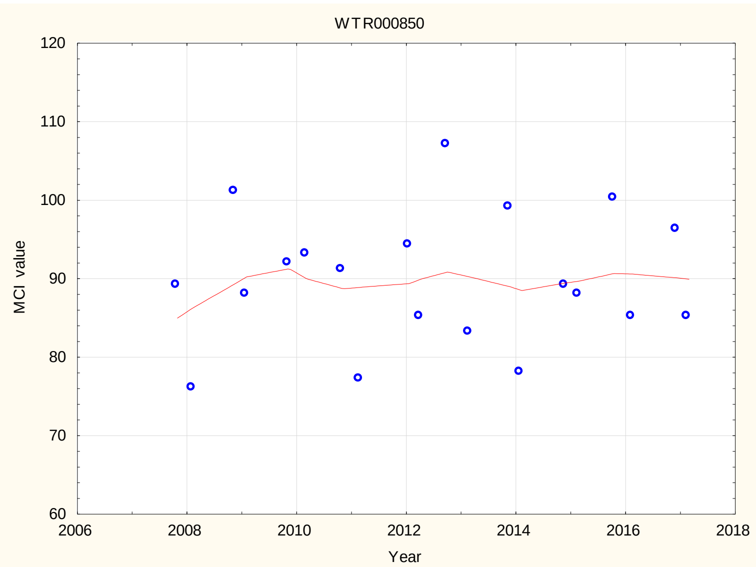
N = 44
Kendall tau = +0.272
p level = 0.009
FDR p = 0.020

Figure 156 LOWESS trend plot of MCI data for the Mamaku Road site, Waitara River

An improvement in MCI scores over the first ten years of monitoring has resulted in an overall significant (p < 0.05 after FDR) positive trend for the 22 year period. This is coincident with work stabilising hill country slopes using vegetation (e.g. poplars) to reduce sediment runoff in this large, predominantly eastern hill country catchment. The trendline range (17 units) has been ecologically important over the period. The trendline has been indicative of a general improvement from 'poor' (in the first few years) to 'fair' generic river health (Table 2).

3.2.24.6 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 157). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waitara River at Mamaku Road.



N = 20
Kendall tau = +0.085
p level = 0.600
FDR p = 0.753

Figure 157 LOWESS trend plot of ten years of MCI data for the Mamaku Road site, Waitara River

No significant change in MCI scores over the most recent ten years of monitoring has occurred contrasting with the significant improvement from the full dataset. This was largely due to the large improvement over the first ten years of the full 22 year monitoring period followed by a relatively stable period. The trendline has been indicative of 'fair' generic river health (Table 2).

3.2.24.7 Discussion

Taxa richnesses for both sites were relatively moderate. The upper site (Autawa Road) had typically higher richnesses than the lower site (Mamaku Road) and recorded taxa richnesses for the lower site were within previous recorded ranges while the upper site, with only four recorded values in total, had a new low of 19 taxa recorded during the summer survey.

The spring survey indicated that both sites were in 'fair' health which was typical for both sites. The summer survey indicated that the upper site was in 'good' health while the lower reach site was in 'fair' health. The score of 102 units at the upper site represeneted the highest recorded score at the site to date. The MCI score only differed by one uint between the two sites in spring but in summer there was a significant decline of 11 units. The decrease in score was proably attributable to diffuse and point source discharges that have caused nutrient enrichment.

The time trend analysis indicated a significant positive trend after FDR adjustment at the lower site for the full dataset indicating that macroinvertebrate health has improved at the lower site over the full 22 year period. No significant trend occurred for the most recent ten year period however and it appears that there has been no recent significant change in macroinvertebrate community health.

3.2.25 Waiwhakaiho River

The Waiwhakaiho River has a source inside Egmont National Park and flows in an easterly direction with its mouth situated in the city of New Plymouth. An additional site was established in the upper reaches of the Waiwhakaiho River for the 2002-2003 SEM programme, to complement the three sites in the central to lower reaches of this large ringplain river, in recognition of its importance as a water resource and particularly its proximity to New Plymouth city. The site was established a short distance inside the National Park boundary at an elevation of 460 m asl. No spring survey was able to be completed due to persistenly high flows. The results from the summer 2017 surveys are presented in Table 164, Appendix I.

3.2.25.1 National Park site (WKH000100)

3.2.25.1.1 Taxa richness and MCI

Twenty-eight surveys have previously been undertaken at this upper reach site just inside the National Park boundary in the Waiwhakaiho River between November 2002 and February 2016. These results are summarised in Table 114, together with the result from the current period, and illustrated in Figure 158.

Table 114 Results of previous surveys performed in the Waiwhakaiho River at National Park together with the summer 2017 result

Site code	SEM data (1995 to Febuary 2016)						2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values			Feb 2017	
		Range	Median	Range	Median		Taxa no	MCI
WKH000100	28	4-29	20	115-147	130		15	136

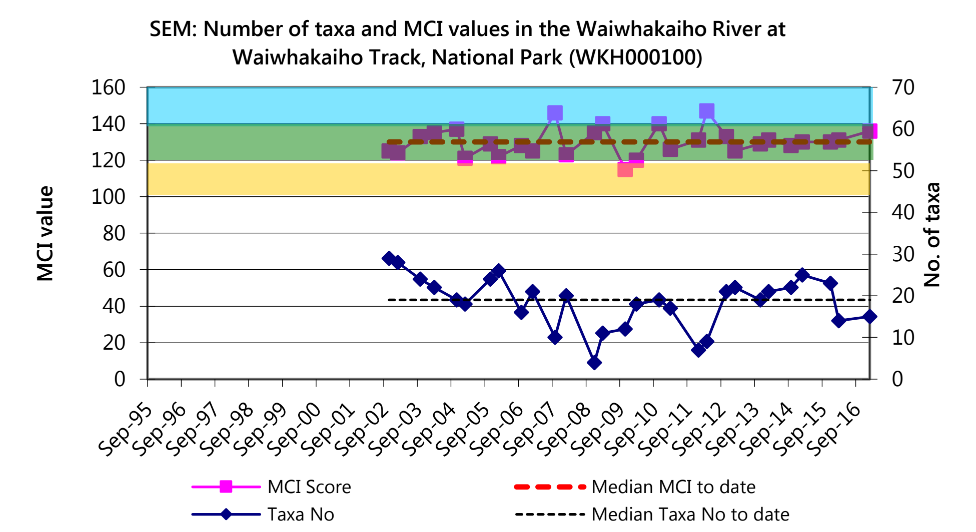


Figure 158 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont National Park

A wide range of richnesses (4 to 29 taxa) has been found, wider than might be expected due to headwater erosion effects over the 2008-2009 period with a median richness of 19 taxa, much lower than typical richnesses [e.g. median of 28 taxa and maximum of 40 taxa] in ringplain streams and rivers near the National Park boundary (TRC, 2016b). During the 2016-2017 period summer (15 taxa) richness was five taxa lower than the median richness.

MCI values have had a wider range (32 units) at this site than typical of a National Park boundary site, due in part to an atypically very high value in 2008 following a marked drop in richness and low values after the 2008-2009 headwater erosion period. The summer 2017 (136 units) score was not significantly different to the historical median and categorised this site as having 'very good' (summer) health generically. The historical median score (130 units) placed this site in the 'very good' category for health.

3.2.25.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 115.

Table 115 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waiwhakaiho River at the National Park between 1995 and February 2016 [28 surveys], and by the summer 2017 survey

Taxa list		MCI score	A	VA	XA	Total	%	Survey Summer 2017
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	2			2	7	
	Deleatidium	8	1	7	20	28	100	XA
	Nesameletus	9	6			6	21	
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	10			10	36	
	Zelandoperla	8	8	11	4	23	82	VA
COLEOPTERA (BEETLES)	Elmidae	6	8	14	4	26	93	VA
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	1			1	4	
	Costachorema	7	2			2	7	

Taxa list		MCI score	A	VA	XA	Total	%	Survey
								Summer 2017
	Hydrobiosella	9	1			1	4	
	Beraeoptera	8	6	3		9	32	
	Olinga	9	1			1	4	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	8	4		12	43	
	Eriopterini	5	3			3	11	
	Maoridiamesa	3		1		1	4	
	Orthocladiinae	2	2			2	7	

Prior to the current 2016-2017 period, 15 taxa had characterised the community at this site on occasions. These have comprised seven 'highly sensitive', five 'moderately sensitive', and three 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected near the National Park boundary of a ringplain stream. However, there have been fewer numerically dominant taxa than are typical in the upper reaches of a ringplain stream. Predominant taxa have included two 'highly sensitive' taxa [mayfly (*Deleatidium* on every sampling occasion) and stonefly (*Zelandoperla*)]; one 'moderately sensitive' taxon [elmid beetles]; but no 'tolerant' taxa.

The summer 2017 community consisted of three characteristic taxa comprising 'sensitive' taxa with a $SQMCI_s$ score of 7.7 units indicating 'excellent' health (Table 114 and Table 164).

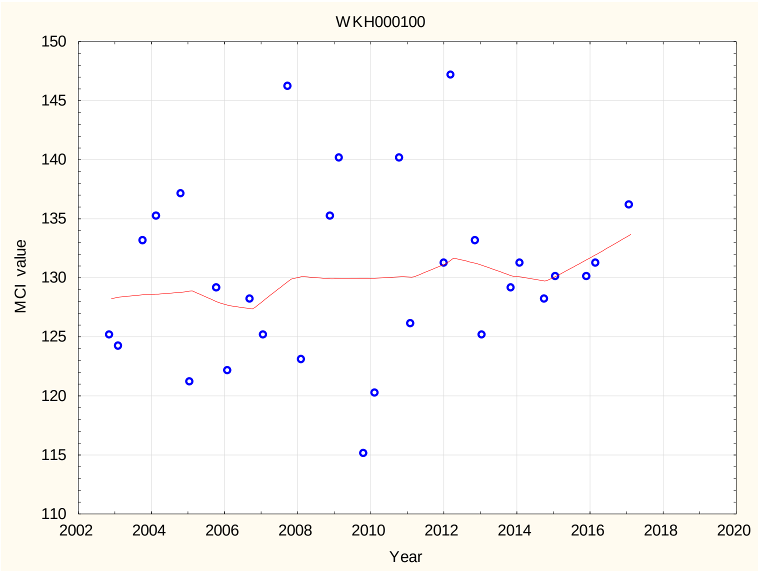
3.2.25.1.3 Predicted stream 'health'

The Waiwhakaiho River site at the National Park is just inside the National Park boundary at an altitude of 460 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median (130 units) and summer survey (136) scores were not significantly different to the distance predictive value.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 134 units. The historical site median and summer scores were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 137 units. Again, the historical site median and summer scores were not significantly different to this value.

3.2.25.1.4 Temporal trends in 2003 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 159). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 14 years of SEM results (2003-2017) from the site in the Waiwhakaiho River at the National Park.



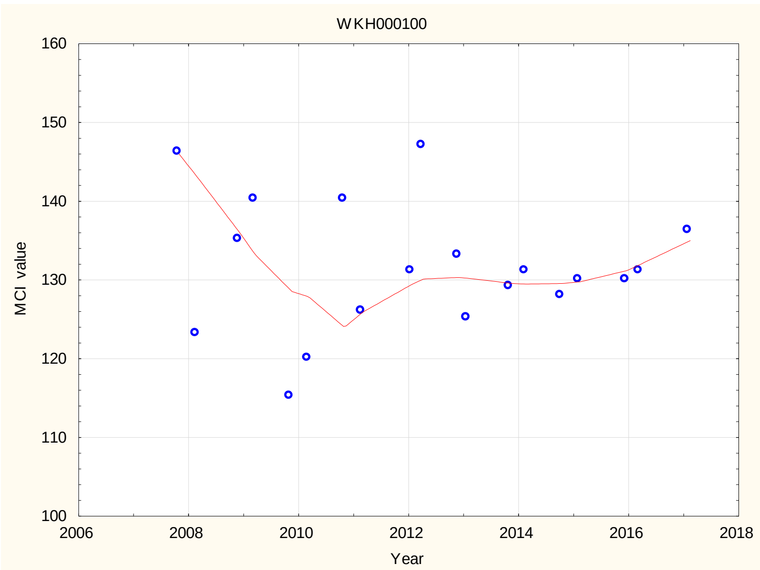
N = 29
Kendall tau = +0.140
p level = 0.286
FDR p = 0.379

Figure 159 LOWESS trend plot of MCI data at the National Park site

No significant temporal trend in MCI scores has been found over the 14 year monitoring period at this site within the National Park. The trendline has a range of only six units have consistently indicated 'very good' generic (Table 2) river health over the period.

3.2.25.1.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 160). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waiwhakaiho River at the National Park.



N = 19
Kendall tau = +0.024
p level = 0.887
FDR p = 0.939

Figure 160 LOWESS trend plot of ten years of MCI data at the National Park site

No significant trend in MCI scores has been found over the ten year monitoring period at this site within the National Park consistent with the full 14 year dataset. The trendline had a range of only five units which consistently indicated 'very good' generic (Table 2) river health over the period.

3.2.25.2 Egmont Village site (WKH000500)

3.2.25.2.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Waiwhakaiho River at this mid-reach site at SH 3, Egmont Village (above the Mangorei Power Scheme) between October 1995 and February 2016. These results are summarised in Table 116, together with the results from the current period, and illustrated in Figure 161.

Table 116 Results of previous surveys performed in the Waiwhakaiho River at Egmont Village together with the summer 2017 result

Site code	SEM data (1995 to Febuary 2016)						2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values			Feb 2017	
		Range	Median	Range	Median		Taxa no	MCI
WKH000500	42	14-32	23	87-122	111		17	122

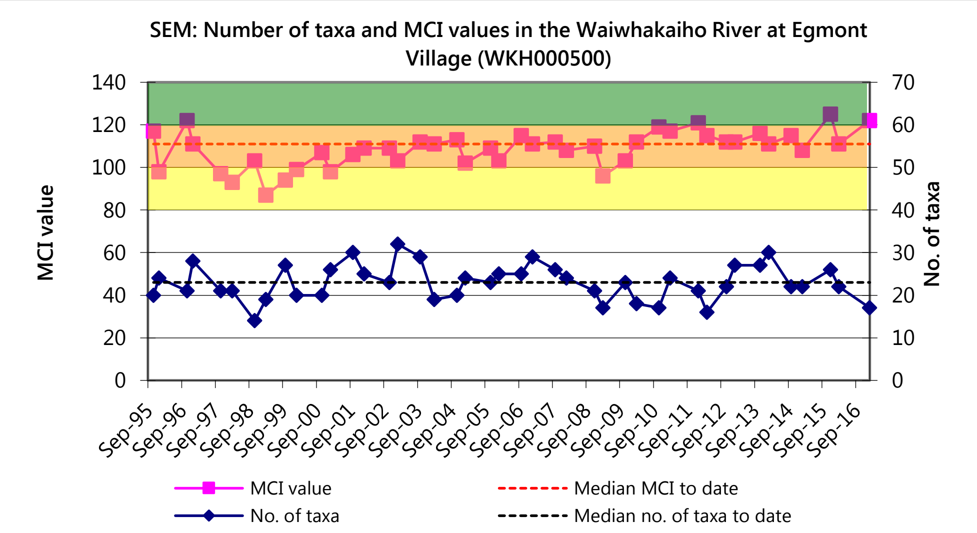


Figure 161 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont Village

A wide range of richnesses (14 to 32 taxa) has been found; wider than might be expected, with a median richness of 23 taxa (more representative of typical richnesses in the mid reaches of ringplain streams and rivers (TRC, 2016b)). During the 2016-2017 period the summer survey had moderate richness (22 taxa) and was six taxa lower than the median taxa number.

MCI values have had a slightly wider range (35 units) at this site than typical of sites in the mid reaches of ringplain rivers but the median value (111 units) has been relatively typical of mid reach sites elsewhere on the ringplain. The summer 2017 score (122 units) was significantly higher than the historic median and categorised this site as having 'very good' health generically. The historical median score (110 units) placed this site in the 'good' category for generic health.

3.2.25.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 117.

Table 117 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waiwhakaiho River at Egmont Village between 1995 and February 2016 [42 surveys], and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey Summer 2017
NEMATODA	Nematoda	3	1			1	2	
ANNELIDA (WORMS)	Oligochaeta	1	6		2	8	19	
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	11	2		13	31	
	Deleatidium	8	10	4	21	35	83	XA
	Nesameletus	9	3			3	7	
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	3			3	7	
COLEOPTERA (BEETLES)	Elmidae	6	16	10		26	62	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	2			2	5	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	18	9	1	28	67	A
	Costachorema	7	14	2		16	38	A
	Hydrobiosis	5	5	1		6	14	
	Neurochorema	6	5			5	12	
	Beraeoptera	8	1			1	2	
	Oxyethira	2	6	2	1	9	21	
	Pycnocentrodes	5	5			5	12	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	24	11		35	83	A
	Eriopterini	5	2			2	5	
	Maoridiamesa	3	20	16	1	37	88	A
	Orthocladiinae	2	16	15	7	38	90	A
	Tanytarsini	3	5	6		11	26	
	Empididae	3	2			2	5	
	Muscidae	3	4			4	10	
	Austrosimulium	3	1			1	2	

Prior to the current 2016-2017 period, 23 taxa had characterised the community at this site on occasions. These have comprised four ‘highly sensitive’, nine ‘moderately sensitive’, and ten ‘tolerant’ taxa i.e. a minority of ‘highly sensitive’ taxa and in comparison with the National Park site, a (downstream) increase in ‘tolerant’ taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included one ‘highly sensitive’ taxon [mayfly (*Deleatidium*)]; two ‘moderately sensitive’ taxa [elmid beetles and cranefly (*Aphrophila*)]; and three ‘tolerant’ taxa [free-living caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)].

The summer 2017 community consisted of seven characteristic taxa comprising ‘tolerant’ and ‘sensitive’ taxa with a $SQMCI_s$ score of 7.1 units indicating ‘excellent’ health (Table 116 and Table 164).

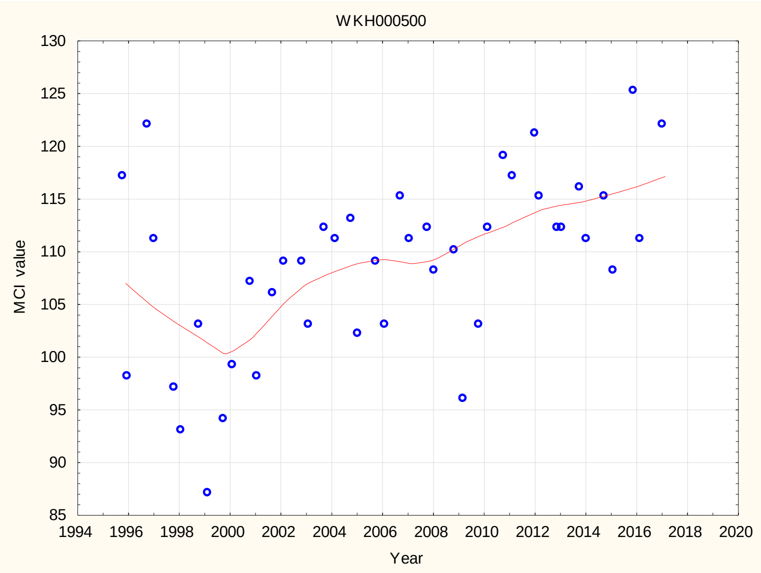
3.2.25.2.3 Predicted stream 'health'

The Waiwhakaiho River site at Egmont Village is 10.6 km downstream of the National Park boundary at an altitude of 175 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 105 for this site. The historical site median (111) was not significantly different to the distance predictive value while the summer 2017 (122 units) scores was significantly higher (17 units).

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 108 units. The historical site median was not significantly different to this value and the summer score was significantly higher (14 units). The REC predicted MCI value (Leathwick, et al. 2009) was 115 units. The historical site median and summer scores were not significantly different to this value.

3.2.25.2.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 162). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waiwhakaiho River at Egmont Village.



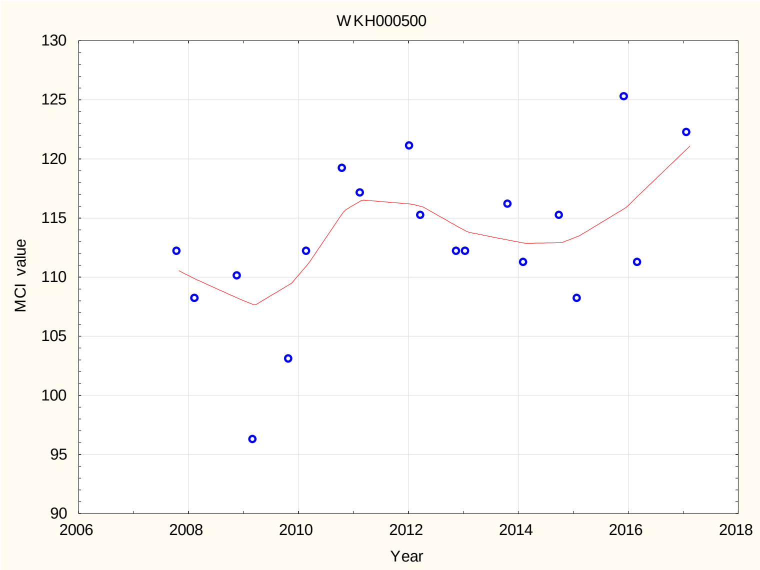
N = 43
Kendall tau = +0.392
p level < 0.001
FDR p < 0.001

Figure 162 LOWESS trend plot of MCI data at the Egmont Village site

A highly significant positive trend in MCI scores (FDR p<0.001) has been found during the 22 year period indicating an overall improvement in macroinvertebrate health at the site. After some initial deterioration in scores, there has been a steady improvement since 1999. While the individual scores were indicative of 'good' to 'fair' generic river health (Table 2) over the first five years, the trendline had a range of 16 units which indicated that macroinvertebrate health has consistently remained 'good'.

3.2.25.2.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 163). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the ten most recent years of SEM results (2007-2017) from the site in the Waiwhakaiho River at Egmont Village.



N = 19
Kendall tau = +0.252
p level = 0.131
FDR p = 0.432

Figure 163 LOWESS trend plot of MCI data at the Egmont Village site

A minor non-significant positive trend in MCI scores has been found contrasting with the highly significant trend found for the full dataset. MCI scores over the last ten years have been relatively similar to each other with some minor variation indicating macroinvertebrate health has plateaued at the site. The trendline was indicative of 'good' macroinvertebrate health rising to 'very good' macroinvertebrate health during the latest survey (Table 2).

3.2.25.3 Constance Street site (WKH000920)

3.2.25.3.1 Taxa richness and MCI

Forty-three surveys have been undertaken in the Waiwhakaiho River at this lower reach site at Constance Street, New Plymouth (below the Mangorei Power Scheme) between 1995 and February 2016. These results are summarised in Table 118, together with the results from the current period, and illustrated in Figure 164.

Table 118 Results of previous surveys performed in the Waiwhakaiho River at Constance Street, New Plymouth, together with spring 2015 and summer 2016 results

Site code	SEM data (1995 to Febuary 2016)						2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values			Feb 2017	
		Range	Median	Range	Median		Taxa no	MCI
WKH000920	44	12-29	20	71-110	94		13	94

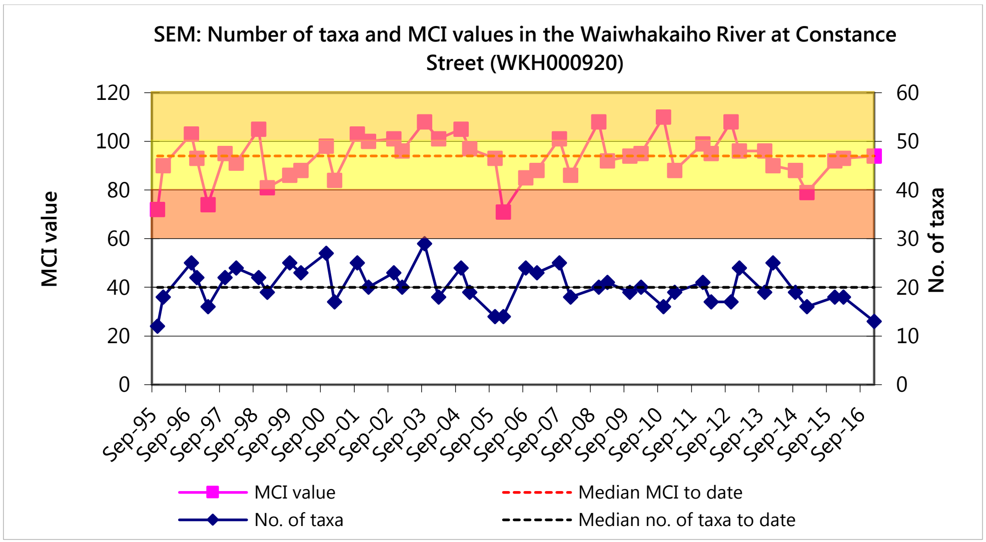


Figure 164 Numbers of taxa and MCI values in the Waiwhakaiho River at Constance Street

A wide range of richnesses (12 to 29 taxa) has been found with a median richness of 20 taxa (more representative of typical richnesses in the lower reaches of ringplain streams and rivers (TRC, 2016b)). During the 2016-2017 period, summer richness (13 taxa) was seven taxa lower than the median richness.

MCI values have had a wide range (39 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (94 units) has been relatively typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2016b). The summer 2017 (94 units) score was the same as the historic median and categorised this site as having 'fair' health generically (Table 2). The historical median score (94 units) placed this site in the 'fair' category.

3.2.25.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 119.

Table 119 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waiwhakaiho River at Constance Street between 1995 and February 2016 [45 surveys], and by the summer 2017 survey

Taxa List		MCI scores	A	VA	XA	Total	%	Survey Summer 2017
NEMERTEA	Nemertea	3	1			1	2	
ANNELIDA (WORMS)	Oligochaeta	1	12	9	5	26	60	
MOLLUSCA	*Potamopyrgus*	4	2	2		4	9	
CRUSTACEA	*Paratya*	3	1			1	2	
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	1			1	2	
	Coloburiscus	7	5			5	12	
	Deleatidium	8	14	7	2	23	53	A
COLEOPTERA (BEETLES)	Elmidae	6	10	2		12	28	
	Staphylinidae	5	1			1	2	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	19	14	1	34	79	

Taxa List		MCI scores	A	VA	XA	Total	%	Survey
								Summer 2017
	Costachorema	7	5	1		6	14	
	Hydrobiosis	5	8			8	19	
	Neurochorema	6	1			1	2	
	Oxyethira	2	8	5		13	30	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	8	1		9	21	
	Maoridiamesa	3	15	5	1	21	49	
	Orthocladiinae	2	23	13	5	41	95	A
	Tanytarsini	3	15	3		18	42	
	Muscidae	3	3			3	7	
	Austrosimulium	3	4			4	9	A

Prior to the current 2016-2017 period, 20 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', eight 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa with a downstream increased proportion of 'tolerant' taxa (compared to the characteristic taxa in the upper and mid-reaches) as would be expected in the lower reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxa [ubiquitous mayfly (*Deleatidium*)]; no 'moderately sensitive' taxa; but three 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges].

The summer 2017 community consisted of three characteristic taxa comprising 'tolerant' and 'sensitive' taxa with a $SQMCI_s$ score of 4.5 units indicating 'fair' health (Table 119 and Table 164).

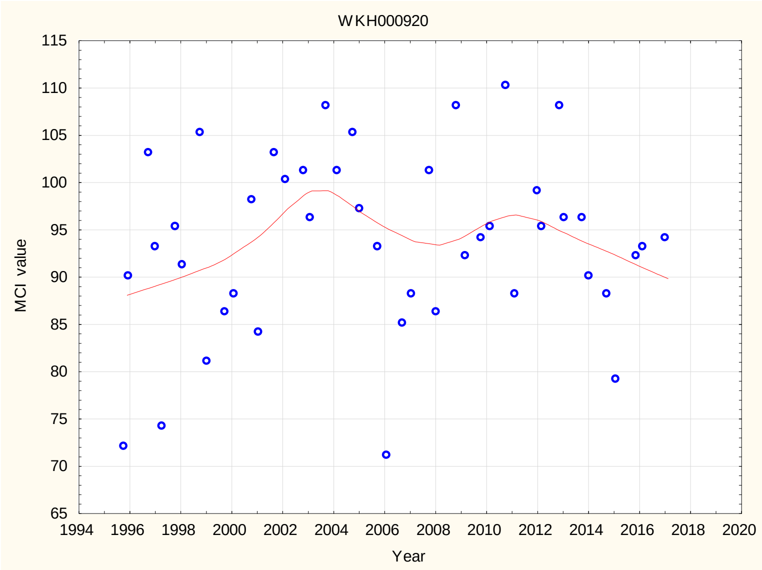
3.2.25.3.3 Predicted stream 'health'

The Waiwhakaiho River site at Constance Street, New Plymouth is 26.6 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 95 for this site. The historical site median (94) and summer 2017 score (94 units) were not significantly different to the distance predictive value (Stark, 1998).

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 90 units. The historical site median and summer scores were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 97 units. The historical site median and summer scores were again not significantly different to this value.

3.2.25.3.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 165). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waiwhakaiho River at Constance Street.



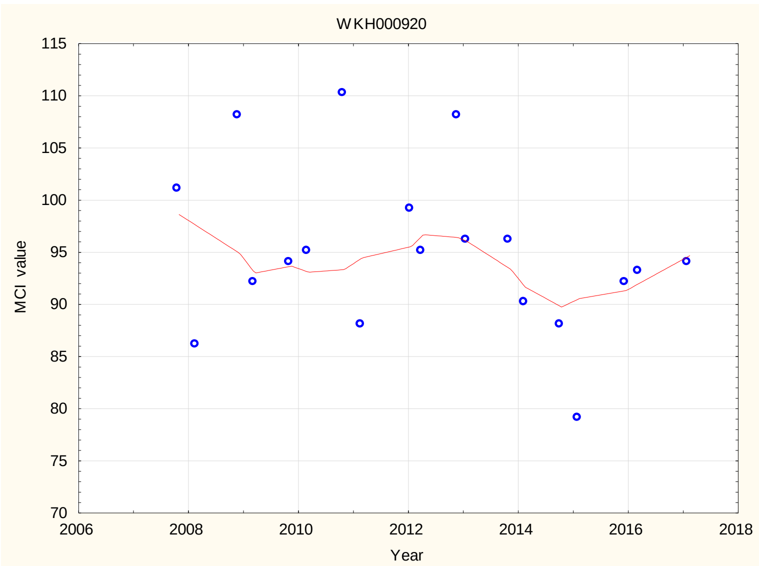
N = 44
Kendall tau = +0.050
p level = 0.630
FDR p = 0.718

Figure 165 LOWESS trend plot of MCI data at the Constance Street site

The overall trend in MCI scores has not been statistically significant for the period, due mainly to some decline and subsequent recovery in scores after 2005 and again since 2012. The trendline had a range of 11 units which indicates variability of some ecological importance. The trendline range indicated 'fair' generic river health for the entire period (Table 2). The trend line was improving toward 'good' health (after a small increase in summer residual flow releases by the TrustPower Mangorei HEP scheme) from 1995-2003 but subsequently decreased with no overall improvement in health over the monitored period.

3.2.25.3.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 166). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waiwhakaiho River at Constance Street.



N = 19
Kendall tau = -0.185
p level = 0.270
FDR p = 0.558

Figure 166 LOWESS trend plot of ten years of MCI data at the Constance Street site

The overall trend in MCI scores has not been statistically significant which matches that of the full dataset. The trendline was indicative of 'fair' generic river health for the entire period (Table 2).

3.2.25.4 Site adjacent to Lake Rotomanu (WKH000950)

3.2.25.4.1 Taxa richness and MCI

Forty-one surveys have been undertaken in the Waiwhakaiho River at this lower reach site adjacent to Lake Rotomanu between March 1997 and February 2016. These results are summarised in Table 120, together with the results from the current period, and illustrated in Figure 167.

Table 120 Results of previous surveys performed in the Waiwhakaiho River the site adjacent to Lake Rotomanu, together with the summer 2017 result

Site code	SEM data (1995 to Febuary 2016)					2016-2017 surveys	
	No of surveys	Taxa numbers		MCI values		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI
WKH000995	41	12-30	21	70-111	88	21	92

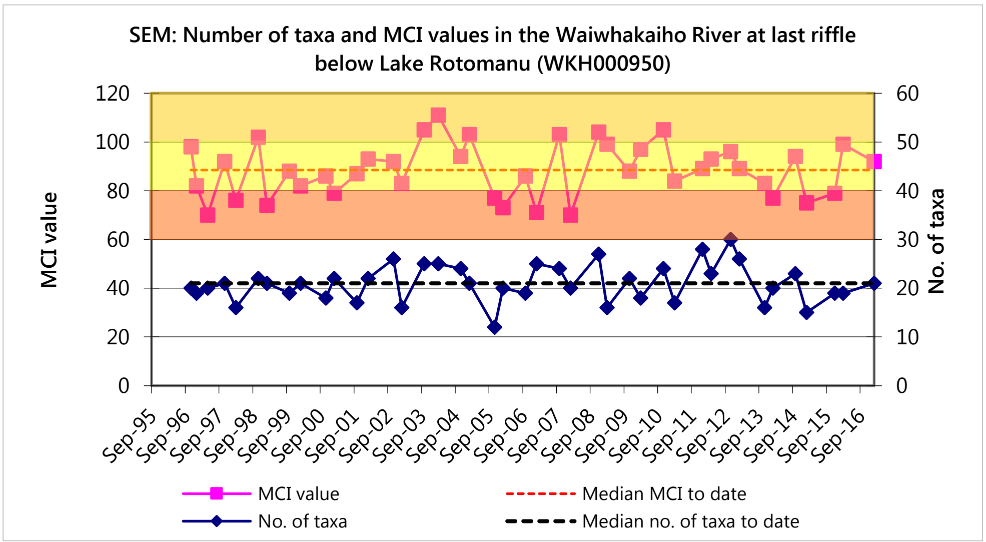


Figure 167 Numbers of taxa and MCI values in the Waiwhakaiho River at Lake Rotomanu

A wide range of richnesses (12 to 28 taxa) has been found; wider than might be expected, with a median richness of 21 taxa. During the 2016-2017 period summer taxa richness (21 taxa) richnesses was the same as the historical median richness.

MCI values have had a wide range (41 units) at this site but typical of variable scores at sites in the lower reaches of ringplain streams. The median value (88 units) has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 2016b). The summer 2017 score (92 units) was not significantly different from the historical median and categorised this site as having 'fair' health generically. The historical median score (88 units) placed this site in the 'fair' generic health category (Table 2).

3.2.25.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 121.

Table 121 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Waiwhakaiho River at the site adjacent to Lake Rotomanu between 1995 and February 2016 [41 surveys], and summer 2017 survey

Taxa List		MCI	A	VA	XA	Total	%	Survey Summer 2017
NEMERTEA	Nemertea	3	3			3	7	
ANNELIDA (WORMS)	Oligochaeta	1	15	8	11	34	83	
MOLLUSCA	*Physa*	3	1			1	2	
	Potamopyrgus	4	12	2	2	16	39	
CRUSTACEA	*Paratya*	3	6	2		8	20	
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	1			1	2	
	Deleatidium	8	7	2	1	10	24	
COLEOPTERA (BEETLES)	Elmidae	6	7	2		9	22	
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	14	11	4	29	71	A
	Costachorema	7	2			2	5	
	Hydrobiosis	5	3			3	7	
	Oxyethira	2	15	1		16	39	
DIPTERA (TRUE FLIES)	*Aphrophila*	5	10	4		14	34	
	Maoridiamesa	3	10	10		20	49	A
	Orthocladiinae	2	14	16	11	41	100	VA
	Tanytarsini	3	11	5		16	39	
	Empididae	3	1			1	2	
	Muscidae	3	1			1	2	
	Austrosimulium	3	1			1	2	

Prior to the current 2016-2017 period, 19 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', five 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a minority of 'sensitive' taxa and a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included no 'highly sensitive' or 'moderately sensitive' taxa; but three 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges).

The summer 2017 community consisted of three characteristic taxa comprising 'tolerant' taxa with a low $SQMCI_s$ score of 2.9 units indicating 'very poor' health ((Table 121and Table 164).

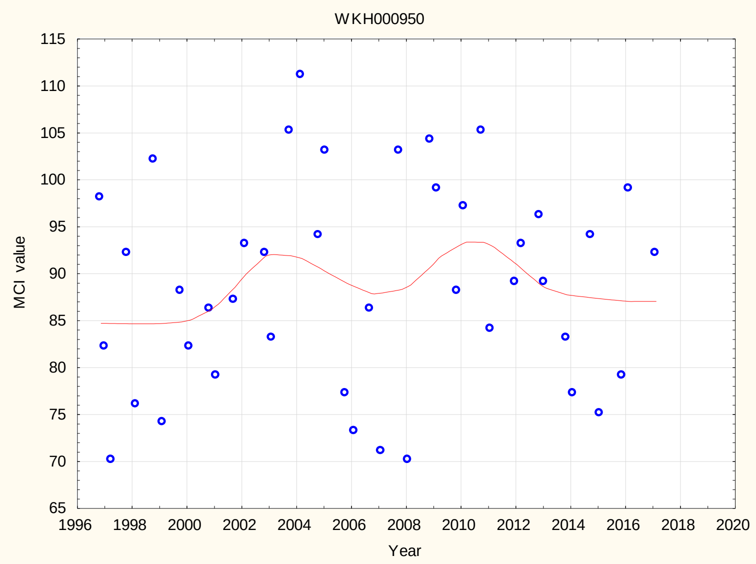
3.2.25.4.3 Predicted stream 'health'

The Waiwhakaiho River at the site adjacent to Lake Rotomanu is 28.4 km downstream of the National Park boundary at an altitude of 2 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 94 for this site. The historical site median and summer 2017 survey were not significantly different to the distance predictive value.

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2016b) was 90 units. The historical site median and summer scores were not significantly different to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 97 units. The historical site median and summer scores were also not significantly different to this value.

3.2.25.4.4 Temporal trends in 1995 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 168). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1995-2017) from the site in the Waiwhakaiho River adjacent to Lake Rotomanu.



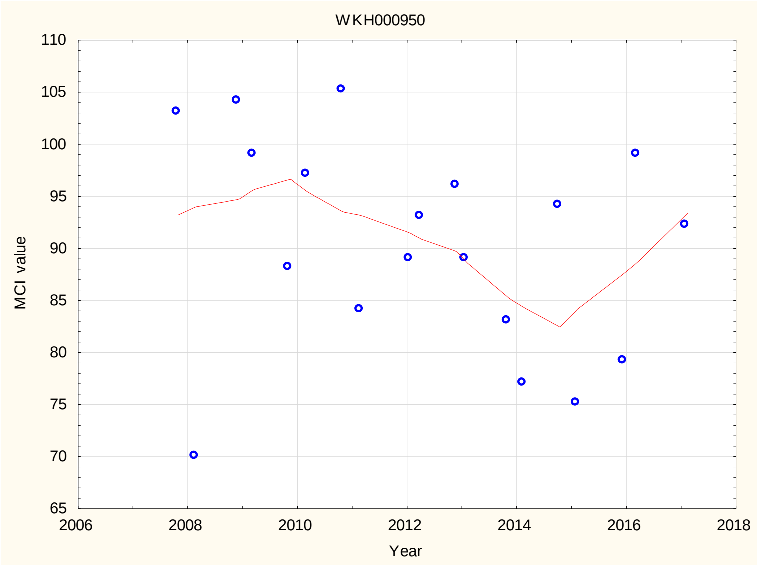
N = 42
Kendall tau = +0.069
p level = 0.519
FDR, p = 0.629

Figure 168 LOWESS trend plot of MCI data at the site adjacent to Lake Rotomanu

Overall, MCI scores have shown no statistically significant trend. There was an improvement from 1995 to 2003 but since 2004, there has been a steady decline in scores toward scores typically found in the first two years of the programme followed by another improvement and subsequent decline, relatively similar trends to those found at the nearest upstream site (Constance St). The trendline covered a range of scores (eight units) of marginal ecological importance which showed slightly more variability over the 2007 to 2015 period. The trendline indicated 'fair' generic stream 'health' (Table 2) throughout the period.

3.2.25.4.5 Temporal trends in 2007 to 2017 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 169). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the most recent ten years of SEM results (2007-2017) from the site in the Waiwhakaiho River adjacent to Lake Rotomanu.



N = 19
Kendall tau = -0.241
p level = 0.149
FDR, p = 0.464

Figure 169 LOWESS trend plot of ten years of MCI data at the site adjacent to Lake Rotomanu

Overall, MCI scores have shown no statistically significant trend congruent with the full dataset results. There was an improvement from 2007 to 2010 but then there was a subsequent decline in the trendline from 2010. The trendline has indicated 'fair' generic stream 'health' (Table 2) throughout the period.

3.2.25.5 Discussion

Taxa richnesses were moderate to moderately low for the four sites during the summer survey. The upper three sites (Waiwhakaiho Track, Egmont Village and Constance St) had richnesses that were lower than usual ranging from four to seven taxa lower than historic medians while the lowerest site (Last riffle below Lake Rotomanu) had a typical taxa richness. Low richnesses may have been due to the persistently high flows that occurred during spring that will have caused macroinvertebrate drift and disrupted communitites.

The summer survey indicated that the two upper sites had macroinvertebrate communities in 'very good' health while the two lowest sites were in 'fair' health. The site at Egmont Village had a significantly higher MCI score while all other sites were either the same or not significantly higher than their historic medians. The MCI score consistently decreased in a downstream direction with an overall decrease of a highly significant 44 units, over a river distance of 28.7 km, indicative of the poorer proceeding water quality at the lower sites.

The time trend analysis indicated a positive significant trend for Egmont Village for the full data set while no other significant trends occurred at other sites. The upper site was unlikely to change in condition as it is in a National Park while the two lower sites are in the city of New Plymouth and were subjected to urban and industrial sources of pollution. The site at Egmont Village has an upstream area dominated by agriculture and significant improvements in macroinvertebrate health at this site was likely due to improvements in the amount of point source and diffuse runoff emanating from farms.

3.2.26 Whenuakura River

The Whenuakura River has a catchment that is in eastern hill country with the lowest portion in the Taranaki sourthern marine terrace. It flows in a southeryly direction with a mouth between the townships of Patea and Waverly. One site in this river was included in the SEM programme in 2015 for the purpose of monitoring an additional site in the eastern hill country. The site is located in the lower reaches of the river at an altitude of approximately 20 m some ten km from the coast.

The results of the 2016–2017 spring and summer surveys are presented in Table 165, Appendix I.

3.2.26.1 Whenuakura River at Nicholson Road site (WNR000450)

3.2.26.1.1 Taxa richness and MCI

This is the second year of monitoring at this lower reach site in the Whenuakura River. These results from the current period are presented in Table 122, and illustrated in Figure 170.

Table 122 Results of previous surveys performed in the Whenuakura River at Nicholson Road, together with spring 2016 and summer 2017 results

Site code	SEM data (2015 to Febuary 2016)					2016-2017 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2016		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WNR000450	2	17-18	18	81-89	85	18	84	29	94

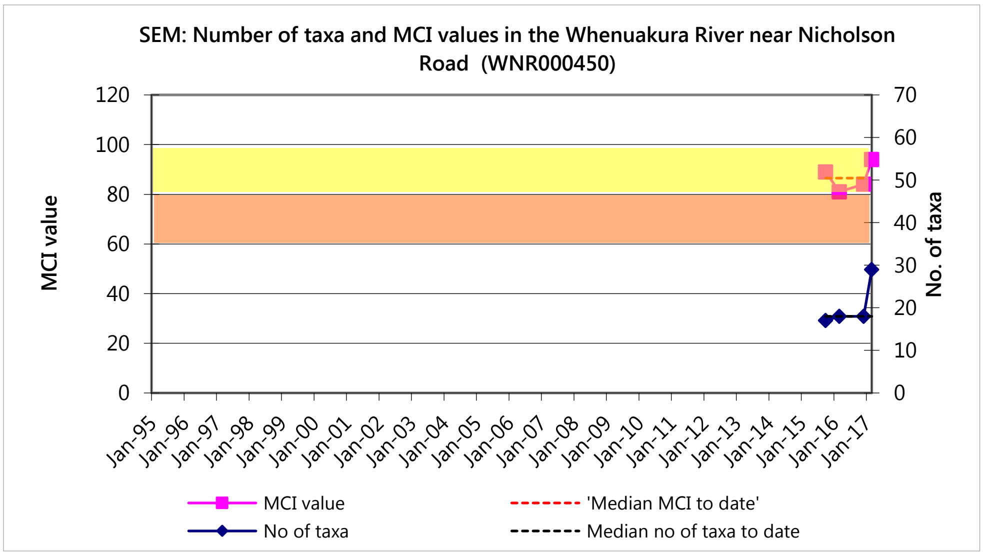


Figure 170 Numbers of taxa and MCI values in the Tangahoe River at Upper Tangahoe Valley Road

During the 2016-2017 period, spring (18 taxa) taxa richness was very similar to the previous two surveys but the the summer (29 taxa) richness was 11 taxa higher than both the spring and historic median.

MCI values have had a narrow range (eight units) at this site which was expected given only two surveys have been completed at the site. The median value (85 units) was slightly higher than was typical (78 units) of mid reach sites elsewhere as recorded at 'control' sites located at similar altitudes in hill country rivers and streams (TRC, 2016b). The spring 2016 (84 units) and summer 2017 (94 units) scores were not significantly different from each other and to the historic median. The scores categorised this site as having 'fair' health (spring and summer) generically. The historic median also classified this site as havig 'fair' health (Table 2).

3.2.26.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2016-2017 period are listed in Table 123.

Table 123 Characteristic taxa [abundant (A), very abundant (VA), extremely abundant (XA)] recorded in the Whenuakura River at Nicholson Road for the spring 2016 and summer 2017 surveys

Taxa List		MCI score	A	VA	XA	Total	%	Survey	
								Spring 2016	Summer 2017
ANNELIDA (WORMS)	Oligochaeta	1	1			1	50		
MOLLUSCA	*Potamopyrgus*	4		1		1	50	VA	VA
CRUSTACEA	*Paracalliope*	5		1		1	50		
	Phreatogammarus	5							VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7						VA	
	Deleatidium	8	1			1	50		
PLECOPTERA (STONEFLIES)	*Acroperla*	5	1			1	50		
COLEOPTERA (BEETLES)	Elmidae	6		1		1	50	A	VA
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	1			1	50		A
DIPTERA (TRUE FLIES)	Orthocladiinae	2		1		1	50	A	
	Tanytarsini	3	1	1		2	100	A	A

Previously there has been one 'highly sensitive', three 'moderately sensitive' and five 'tolerant' taxa recorded at the site with only one characteristic taxon, the 'tolerant' midge *Tanytarsini*, present during both surveys (Table 123).

The spring 2016 community consisted of five characteristic taxa comprising 'sensitive' and 'tolerant' taxa comprising 'tolerant' taxa with a moderate $SQMCI_s$ score of 5.0 units indicating 'good' health. The summer 2017 community consisted of five characteristic taxa comprising 'sensitive' and 'tolerant' taxa with a $SQMCI_s$ score of 4.4 units indicating 'fair' health (Table 123 and Table 165).

3.2.26.1.3 Predicted stream 'health'

The Whenuakura River at Nicholson Road, at an altitude of 20 m asl, is toward the lower reaches of this low gradient river draining an eastern hill country catchment.

The median value for an eastern hill country streams (TRC, 2016b) at a similar altitude was 78 units. The spring score (84 units) was not significantly higher than this value and the summer score (94 units) was significantly higher by 16 MCI units. The REC predicted MCI value (Leathwick, et al. 2009) was 109 units and therefore the spring and summer scores were both significantly lower than this value (Stark, 1998).

3.2.26.1.4 Temporal trends in data

There was insufficient data to perform time trend analysis which requires a minimum of ten years data.

3.2.26.2 Discussion

Taxa richness moderate during spring and moderately high during summer with an 11 taxa increase in summer, which contrasts with the previous two surveys that only differed by one taxon. This indicates that the site can have quite high taxa numbers despite being a soft bottom stream with high turbidity and that significant seasonal fluctuation in numbers can occur. Taxa numbers may have increased over summer due to more food availability during the warmer, sunnier period. Taxa numbers were also higher than the median number for similar eastern hill country streams (15 taxa), especially for the summer survey (29 taxa) which was a new record high for the site and close to the record (32 taxa) for all similar eastern hill country streams (TRC, 2016b).

The site was in 'fair' health during both spring and summer at the time of surveys. There was no significant variation in MCI score between the two surveys and compared with the historic median and the summer score was significantly higher than the median for similar stream possibly indicating that the site or river had higher than normal macroinvertebrate health compared with other eatern hill country streams and rivers.

4 General discussion and conclusions

The detection of trends in the biological data requires a data set of suitable period and collected using rigid, acceptable protocols, to be statistically valid e.g. a minimum of ten years of spring and summer surveys. With 22 years of data available for most sites, temporal trend analyses have been updated further within this report. For the second time, there has also been analysis presented of the results from the most recent ten year period for each site where available. This represents a compromise between degree of certainty in any apparent trends, and an indication of current as distinct from historical directions of travel. Other comments in relation to the data collected in the period 1995 to 2017, are presented briefly below. These data are summarised in Appendix II and illustrated in Figures 121 to 127.

4.1 Macroinvertebrate fauna communities

In general terms, data have indicated that the macroinvertebrate communities at sites in upper reaches of catchments have been comprised of a greater proportion of taxa that are 'sensitive' to the effects of nutrient enrichment or a poorer state of habitat, compared with communities in the mid and lower reaches of catchments. These changes in community composition have resulted from the effects of nutrient enrichment, increased sunlight (less riparian shading), higher temperatures, increased algal growth (a partial consequence of the former), lower in-stream velocities, and finer substrate (sedimentation), coincident with poorer physicochemical water quality in the lower reaches of streams and rivers.

Taxa richnesses (number of different taxa) at most sites in these streams and rivers more often showed higher richnesses in the upper reaches of catchments (with the exception of those affected by preceding headwater erosion events), with more seasonal variability in richnesses further downstream. Seasonal richnesses often have tended to be higher in summer than in spring, particularly at lower reach sites.

Macroinvertebrate community index: Over the 22 year period, sites in the middle and the lower reaches of streams and rivers generally have had lower summer MCI scores than spring MCI scores as evidenced by overall decreases in mean scores by four units, whereas median seasonal scores at upper reach sites have differed by only one unit on average. This difference has been coincident with summer warmer water temperatures increased periphyton substrate cover and lower flows, resulting in additional less 'sensitive' taxa being present and/or increases in the abundance of lower scoring 'tolerant' taxa, combined with lifecycle patterns. Some taxa will be present in spring as large nymphs but will not be recorded in summer samples as they will be at an egg or first instar (usually impossible to ID to genus) stage.

Furthermore, the results from the 2016-2017 period excluding sites with no spring survey have shown that:

- at all sites, spring MCI scores (mean 105 units) were higher (by two units) than summer scores (mean 103 units), while the median spring scores were one MCI unit lower than the median summer score
- 14 sites had a higher MCI score in spring than in summer, while 15 sites had a higher MCI score in summer than in spring
- a t-test of spring and summer MCI scores (also excluding the two new 2015-2016 sites) showed that there was no significant seasonal variation (N=30, t-value = 0.28, p = 0.78)
- at upper reach sites there was an increase in average MCI score of seven units in summer which was not statistically significant ((N=2, t-value = -0.69, p = 0.56)
- at mid reach sites, a decrease in average MCI score of one unit in summer was not significant ((N=14, t-value = 0.31, p = 0.76)
- at lower reach sites, a similar decrease in average MCI scores of three units in summer was not significant ((N=12, t-value = 1.61, p = 0.12)
- at all sites (excluding the two new 2015-2016 sites), the spring 2016 average MCI score was two units higher than long term (22 year) average of spring median scores, but this difference was not significant ((N=30, t-value = 0.51, p = 0.61)

- at all sites (excluding the two new 2015-2016 sites), the summer 2017 average MCI score was three units higher than the long term (22 year) average of summer median scores, but this difference was also not significant (N=57, t-value = 0.74, p = 0.46)

There were six new maxima MCI site scores (higher by 1-6 units) recorded during the 2016-2017 period including new records for the two data depuarate sites established in 2015. This is less than the 11 new maxima detected in the preceding 2015-2016 period for the same site selection. However, fewer surveys were conducted for the current monitoring year due to persistently high flows during spring, and the number of new maxima was similar to the 2014-2015 period which had three new maximas. One historical minimum MCI site score was recorded during the 2016-2017 period, the same as in the preceding year.

4.1.1 Spring and summer MCI values vs median values and predictive scores

The MCI scores from the spring and summer surveys are compared with the medians generated from 22 years of data (1995-2017) from the SEM programme and with two predictive scores (summarised in Appendix II): modelled based on distance from the National Park, and referenced against equivalent REC sites (national). Those sites' median MCI scores which deviated significantly (> 10 MCI units) from predicted scores are summarised in Table 125 (section 4.1.3.4) and listed individually in Appendix II.

4.1.2 Spring surveys

4.1.2.1 Historical SEM

Twenty-eight of the 32 sites able to be surveyd during spring had MCI scores which were not significantly different (within ten units) to their historical medians. Three sites had a significantly better than normal score while one site had significantly worse than normal score (Figure 171). In addition, two sites had scores that were between five to ten units higher and two sites had scores that were between five to ten units lower than historical spring medians.

Figure 171 Spring 2016 MCI scores in relation to SEM historical spring median values

In summary, 88% of sites showed no significant detectable differences (Stark, 1998) between spring, 2016 MCI scores and historical median scores, while 9% of sites had significantly higher and 3% of sites had significantly lower spring 2016 MCI scores.

4.1.2.2 Predictive TRC ringplain distance model (distance from Egmont National Park)

Predictive scores have been developed for ringplain sites with their sources inside the National Park in relation to distance from the National Park (Stark and Fowles, 2009). Spring scores have been assessed against predicted scores for distance in Figure 172.

Figure 172 Spring 2016 MCI scores in relation to predicted downstream distance scores

Ten sites had spring MCI scores more than five units above the distance predicted values with seven of these sites have scores significantly higher (>10 units) than predicted. Only one site had a score more than five units lower than predicted with no sites recording scores significantly lower than predicted. Ten sites had spring scores within five MCI units of predicted scores.

In summary, 78% of sites showed no significant detectable difference (Stark, 1998) between spring 2016 scores and predicted distance (from the National Park) scores, while 22% of sites had significantly higher spring 2016 MCI scores and 0% of sites had a significantly lower spring 2016 score.

4.1.2.3 Spring MCI scores in relation to the REC predictive score

Leathwick (2009, pers comm.) has developed predictive scores based upon the River Environmental Classification (REC) system for New Zealand rivers and streams (Snelder et al, 2004). REC classifies and maps river and stream environments in a national spatial framework for management purposes. It provides a context for inventories of river/stream resources and a spatial framework for effects assessment, policy development, developing monitoring programmes, and interpretations of state of the environment reporting.

Spring MCI scores have been compared with the REC predictions for all 32 sites surveyd for spring 2016. REC predictions are calculated by averaging current MCI scores for a particular REC segment type as well as taking into account other additional environmental and physically factors (see Leathwick, 1998).

Three sites had spring MCI scores more than five units above predicted values (Figure 173) with all three of these sites significantly higher than predicted. Fourteen sites had spring scores within five MCI units of predicted scores while 15 sites' scores were more than five units lower than predicted, nine of which were significantly lower (>10 units) than predicted.

Figure 173 Spring 2016 MCI scores in relation to REC predictive values

In summary, 44% of sites showed no significant detectable difference (Stark, 1998) between spring 2016 scores and predicted REC scores, while 9% of sites (three sites) had significantly higher spring 2016 MCI scores and 28% of sites (nine sites) had a significantly lower than predicted spring 2016 score.

4.1.3 Summer surveys

4.1.3.1 Historical SEM

A majority (51 of 59 sites) of sites' faunal communities' MCI scores were similar to (within 10 units) historical SEM site median scores (Figure 174). Significantly higher scores were found at seven sites, while only one site had a MCI score significantly lower than its historic median score.

Figure 174 Summer 2017 MCI scores in relation to SEM historical median values

Significantly higher scores were found in sites located in the Maketawa, Kaupokonui, Waiwhakaiho, Huatoki (two sites), Timaru, and Patea streams and rivers coincident with improving water quality at the majority of those sites. The one significantly lower score occurred in the mid reaches of the Manganui River.

In summary, 86% of sites showed no significant detectable differences (Stark, 1998) between summer 2017 MCI scores and historical median scores, while 12% of sites had significantly higher summer 2017 scores and 2% of sites had significantly lower summer 2017 scores.

4.1.3.2 Predictive TRC ringplain distance model

Summer scores for each ringplain site have been assessed against predicted scores (Stark and Fowles, 2009) for distance from the National Park boundary for those ringplain sites with sources inside the inside the National Park (Figure 175)

Thirteen sites had summer MCI score more than five units above predicted values (Figure 175) with nine of these sites' scores significantly higher than predicted values. Twenty-three sites had summer scores within five units of predicted scores, while two sites' scores were more than five units lower than predicted with both of those sites significantly lower than derived values.

Figure 175 Summer 2016 MCI scores in relation to predicted downstream distance scores

In summary, 81% of sites showed no significant difference (Stark, 1998) between summer 2017 MCI scores and predicted distance (from National Park) scores, while 15% of sites had significantly higher summer scores and 3% of sites had significantly lower summer scores.

4.1.3.3 Summer MCI scores in relation to the REC predictive scores

Summer MCI scores have been compared with the REC predictions for all 59 sites. REC predictions are calculated by averaging current MCI scores for a particular REC segment type as well as taking into account other additional environmental and physically factors (see Leathwick, 1998).

Eleven sites had summer MCI scores more than five units above predicted values (Figure 178) with five of these sites significantly higher than predicted. In constrast, 23 sites had scores of more than five below predicted levels and of these 14 were significantly lower.

Overall, Taranaki summer MCI scores were more likely to be below than above values that were derived from a national dataset.

Figure 176 Summer 2017 MCI scores in relation to REC predictive values

4.1.3.4 Predictive value overview

The general seasonal trend in MCI scores is summarised in Table 124, which provides the percentages of sites' scores in relation to predicted scores.

Table 124 Percentages of spring and summer MCI scores for ringplain sites with sources arising in the National Park in relation to predicted distance from National Park boundary score (Stark and Fowles, 2009) and national REC-based scores (Lethwick, 1998)

Season	Spring 2016			Summer 2017		
Prediction	> 10 units higher	± 10 units	> 10 units lower	> 10 units higher	± 10 units	> 10 units lower
Distance	22	78	0	15	81	3
REC	9	63	28	8	68	24

In general, MCI scores were more likely to be significantly higher than lower for predictive distance scores with the majority of sites not significantly different to predictive scores. This was probably due to sites having improved since the distance-based predictive equations were created using data from 1981-2006.

The more recently created REC predictive scores showed the opposite pattern, with more sites being significantly lower than significantly higher than predictive scores though the majority were not significantly different (Stark, 1998) to predictive scores, which might indicate that Taranaki sites were in not as good a condition as general NZ sites. However, results are further complicated by the Council using Taranaki specific tolerance values compared with national values which may distort the analysis.

Table 125 Percentages of sites (2016-2017) showing significant differences (>10 MCI units) from the various predicted scores

Sites	Deviation from predicted scores			
	Distance[1]		REC[2]	
	Lower	Higher	Lower	Higher
Upper reaches	0%	44%	9%	36%
Mid reaches	0%	35%	30%	9%
Lower reaches	11%	5%	21%	0%
All sites	3%	27%	24%	9%

[Notes: Stark and Fowles, 2009[1]; Leathwick, 2008[2]]

A significant percentage of sites' scores differed significantly from predictions based on distance from the National Park boundary, with a greater proportion of actual scores higher than predicted. There was however a marked difference in this pattern further downstream, with only 5% (1 site) of sites in the lower reaches having a MCI score significantly above the predicted value. A similar pattern was observed for REC predictive values, with upper reach sites more likely to have significantly higher MCI values while mid to lower reach sites more likely to have significantly lower MCI values than comparative national values.

Table 126 Percentages of sites with historic medians (1995-2016) showing significant differences (>10 MCI units) from the various predicted scores

Sites	Deviation from predicted scores			
	Distance[1]		REC[2]	
	Lower	Higher	Lower	Higher
Upper reaches	0%	14%	9%	0%
Mid reaches	0%	17%	26%	4%
Lower reaches	8%	0%	32%	0%
All sites	3%	11%	25%	2%

Sites in the lower reaches of shorter ringplain streams (e.g. Punehu, Kapoaiaia and, in particular the Waimoku Stream), have had historical median MCI scores showing the greatest disparity between actual and predicted scores for distance from the National Park (see Appendix II). Care needs to be used when comparing actual scores with predictive score as there is likely to be discrepancies, as predictive values are not likely to be perfect and give only a generalised indication of what a site's MCI score is likely to be.

Only one median MCI score (Huatoki Stream at the Domain, New Plymouth) significantly exceeded predicted scores based upon the REC system, whereas 25% of sites' scores were significantly lower. No upper reach sites had significantly lower scores and the percentage significantly below the predictive score increased from the upper to the lower reach sites. It should be noted that SEM median MCI scores effectively incorporate equal proportions of spring and summer scores and that the maximum scores for each site (over the 1995 to 2016 period) (invariably recorded in spring) have often exceeded the REC predicted scores.

Ranking sites, on the basis of median SEM MCI scores for the 22-year period to date, may be attempted in terms of deviation from the predicted scores for distance from the National Park boundary (for ringplain sites) and REC predicted scores (for all sites). This effectively indicates which sites are 'better than expected' or 'worse than expected' once the particular characteristics of the site are taken into account (to the extent that these characteristics are accounted for in the modelling). Table 127 provides the rankings on this basis of the best and poorest sites in the SEM programme.

Table 127 Ranking of five best and worst sites' median MCI scores (1995-2017) based on deviation from predictive scores

	Distance from National Park	REC
BEST	Waingongoro R @ Opunake Rd	Huatoki S @ Domain
	Patea R @ Barclay Rd	Patea R @ Barclay Rd
	Manganui R. SH3	Kapoaiaia S @ Wiremu Rd
	Kaupokonui S @ Opunake Rd	Katikara S @ coast
	Waingongoro R @ SH45	Waingongoro R @ Opunake Rd
WORST	Waimoku S @ coast	Mangaehu Rd @ Raupuha Rd
	Kapoaiaia S @ coast	Whenuakura R @ Nicholson RD
	Punehu S @ SH 45	Mangati S @ Bell Block
	Kapoaiaia S @ Wataroa Rd	Kaupokonui S @ u/s Lactose Co.
	Waiwhakaiho R @ coast	Mangawhero S @ Eltham

The majority of the best ranked sites were located higher up the catchment. However, the Waingongoro River site at SH45 is located in the lower reach close to the coast. The site has good riparian vegetation and swift flow which probably contributed to its better than predicted score. The Huatoki Stream in the Domain at New Plymouth has extensive riparian cover provided by the Domain constituting of intact native bush, but is excluded from the distance ranking as this stream is sourced outside of the National Park.

The majority of the poorest ranked streams were located in the lower reaches of catchments with the Kapoaiaia Stream (with very limited riparian cover) notable for its poor ranking at two sites. The Mangaehu River and the two small, non-National Park sourced streams (Mangati and Mangawhero), which used to receive significant point source discharges rank poorly in terms of the REC predictions. (Note: these streams and river sites were excluded from the distance predictive rankings as these catchments are located well away from the National Park).

Figure 177 Generic biological 'health' (based on median MCI) and trends in biological quality for SEM sites, 1995 to 2017

4.1.4 Stream 'health' categorisation

A gradation of biological water quality conditions based upon ranges of MCI scores has been used to determine the 'health' generically (Table 2) of each site by utilising the median score from up to a 22-year period (1995-2017). These assessments are summarised in Appendix II. The 'health' of streams in relation to the location of sites (upper, middle and lower reaches) in catchments is summarised in Table 128.

Table 128 Stream 'health' site assessments according to catchment reach (in terms of median MCI score, 1995-2017)

'Health' grading (MCI score range)	Reaches		
	Upper	Middle	Lower
Excellent (>140)	0	0	0
Very good (120-140)	7	4	0
Good (100-119)	1	11	3
Fair (80-99)	0	11	18
Poor (60-79)	0	2	2
Very poor (<60)	0	0	0
Median ranges (MCI units)	100-138 (38)	75-130 (54)	66-109 (43)

Typically generic 'health' (in terms of median MCI scores) decreases in a downstream direction from 'very good' in the upper reaches of catchments, through predominantly 'good-fair' in the middle reaches, to mainly 'fair' in the lower reaches toward the coast. Each site's 'health' may vary between seasons, but seldom by no more than one category (grading) either side of this median grading in response to preceding stream flow and associated habitat (physical and physicochemical water quality) conditions. In this regard generally there has been a similar level of seasonal variability in scores between middle and lower catchment sites (on average both decrease by four MCI units from spring to summer). Upper catchment sites showed far less variability with on average only a one MCI unit decrease from spring to summer. However, there were also far fewer upper reach sites surveyed compared with middle or lower reach sites which limits the usefulness of direct comparisons examining total variability.

4.1.5 Comments

The decreasing gradient of stream 'health', from 'very good' in the upper reaches of ringplain streams to 'fair' in the lower reaches, is indicative of a downstream change in macroinvertebrate communities towards those that are comprised of taxa more 'tolerant' of organic enrichment and/or physical habitat deterioration in the lower reaches. These communities have become well adapted to the cumulative impacts of upstream point source discharges and diffuse run-off and are particularly resistant to further impacts (other than toxic discharges). Therefore, in most lower reach communities significant improvement of water quality and habitat would have to occur before changes would be statistical and ecological significant.

Thus, while maintenance of ('fair') stream 'health' occurs in the lower reaches of ringplain catchments (as these communities are very 'tolerant' of cumulative organic impacts), temporal trends of improvement in stream 'health' are unlikely to be statistically evident until appropriate management initiatives are substantially progressed on a catchment wide basis. Having said that, of the 4 sites that are graded 'poor', 3 are showing trends of a very significant improvement (Figure 177). Enhancement of stream health, particularly at the sites in the lower reaches of ringplain streams, is unlikely to be significant and/or important until marked improvements in habitat and water quality occur. These may be implemented for instance by way of a combination of riparian fencing/planting initiatives and re-direction of dairy pond treatment system discharges from direct disposal into surface waters to irrigation to land.

4.2 Macroinvertebrate fauna MCI trends

Temporal trends measured over the monitoring period between 1995 and 2017 (Table 129, and Appendix II) indicated that 30 sites had significantly improving MCI scores (FDR p<5%) with 23 of those sites having highly significantly MCI scores (FDR p<1%)[3] during the period. Only one site had a significantly deteriorating score. Two sites could not be trended due to the shorter duration of monitoring at these sites.

Forty-nine sites show a positive (improving) direction of travel, while 8 show a negative direction of travel, across the full historical record.

For the most recent 10-year period, 39 sites show a positive direction of travel, 12 a negative direction of travel, and 8 had insufficient records to analyse, or were showing no overall indications of change.

Table 129 Summary of Mann-Kendall test results for MCI scores trended over time (1995-2017) for 59 Taranaki streams/rivers (p with FDR applied) (significant = p<0.05 and highly significant = p<0.01)

River/stream name	Site code	N	FDR[3] p level	+/- (ve)	Significance	Ecological importance (Trendline MCI range)
Hangatahua (Stony) R	STY000300	46	0.10	-ve	Not significant	16
Hangatahua (Stony) R	STY000400	46	0.84	-ve	Not significant	16
Herekawe S	HRK000085	43	0.01	+ve	Significant	12
Huatoki S	HTK000350	41	<0.01	+ve	Highly significant	15
Huatoki S	HTK000425	41	<0.01	+ve	Highly significant	10
Huatoki S	HTK000745	41	0.94	-ve	Not significant	13
Kapoaiaia S	KPA000250	36	<0.01	+ve	Highly significant	30
Kapoaiaia S	KPA000700	36	<0.01	+ve	Highly significant	28
Kapoaiaia S	KPA000950	36	0.06	+ve	Not significant	13
Katikara S	KTK000150	35	0.03	-ve	Significant	15
Katikara S	KTK000248	34	0.82	+ve	Not significant	18
Kaupokonui R	KPK000250	37	0.24	+ve	Not significant	37
Kaupokonui R	KPK000500	40	0.01	+ve	Significant	20
Kaupokonui R	KPK000660	44	<0.01	+ve	Highly significant	33
Kaupokonui R	KPK000880	44	0.01	+ve	Significant	15
Kaupokonui R	KPK000990	36	0.02	+ve	Significant	14
Kurapete S	KRP000300	44	<0.01	+ve	Highly significant	20
Kurapete S	KRP000660	44	<0.01	+ve	Highly significant	17
Maketawa S	MKW000200	34	0.94	+ve	Not significant	12

[3] FDR= one of the methods used to make the statistical analysis more stringent, by eliminating cases where a random distribution of results might create a pattern that appears meaningful.

River/stream name	Site code	N	FDR[3] p level	+/- (ve)	Significance	Ecological importance (Trendline MCI range)
Maketawa S	MKW000300	33	<0.01	+ve	Highly significant	17
Mangaehu R	MGH000950	44	<0.01	+ve	Highly significant	19
Manganui R	MGN000195	46	0.32	-ve	Not significant	9
Manganui R	MGN000427	44	0.47	+ve	Not significant	7
Mangaoraka S	MRK000420	43	<0.01	+ve	Highly significant	16
Mangati S	MGT000488	44	0.54	+ve	Not significant	9
Mangati S	MGT000520	44	<0.01	+ve	Highly significant	24
Mangawhero S	MWH000380	44	<0.01	+ve	Highly significant	6
Mangawhero S	MWH000490	44	<0.01	+ve	Highly significant	17
Mangorei S	MGE000970	29	0.23	-ve	Not significant	11
Patea R	PAT000200	44	0.30	+ve	Not significant	8
Patea R	PAT000315	44	0.08	+ve	Not significant	6
Patea R	PAT000360	44	0.55	+ve	Not significant	3
Punehu S	PNH000200	44	<0.01	+ve	Highly significant	15
Punehu S	PNH000900	44	<0.01	+ve	Highly significant	20
Tangahoe R	TNH000090	20	0.21	+ve	Not significant	8
Tangahoe R	TNH000200	20	0.84	-ve	Not significant	7
Tangahoe R	TNH000515	20	0.83	+ve	Not significant	10
Timaru S	TMR000150	43	0.23	+ve	Not significant	9
Timaru S	TMR000375	43	<0.01	+ve	Highly significant	18
Waiau S	WAI000110	36	<0.01	+ve	Highly significant	11
Waimoku S	WMK000100	35	0.73	+ve	Not significant	5
Waimoku S	WMK000298	35	<0.01	+ve	Highly significant	12
Waingongoro R	WGG000115	45	0.24	+ve	Not significant	8
Waingongoro R	WGG000150	45	0.73	+ve	Not significant	9
Waingongoro R	WGG000500	48	<0.01	+ve	Highly significant	10
Waingongoro R	WGG000665	44	<0.01	+ve	Highly significant	12
Waingongoro R	WGG000895	45	0.373	+ve	Not significant	5
Waingongoro R	WGG000995	44	0.04	+ve	Significant	11
Waiokura S	WKR000500	25	<0.01	+ve	Highly significant	10
Waiokura S	WKR000700	20	0.87	-ve	Not significant	5
Waiongana S	WGA000260	44	0.04	+ve	Significant	9
Waiongana S	WGA000450	43	<0.01	+ve	Highly significant	18
Waitara R	WTR000540	44	N/T	-	-	-

River/stream name	Site code	N	FDR[3] p level	+/- (ve)	Significance	Ecological importance (Trendline MCI range)
Waitara R	WTR000850	44	0.02	+ve	Significant	17
Waiwhakaiho R	WKH000100	29	0.38	+ve	Not significant	6
Waiwhakaiho R	WKH000500	43	<0.01	+ve	Highly significant	16
Waiwhakaiho R	WKH000920	44	0.72	+ve	Not significant	11
Waiwhakaiho R	WKH000950	42	0.63	+ve	Not significant	8
Whenuakura R	WNR000450	44	N/T	-	-	-

[Not significant = not statistically significant (ie $p \geq 0.05$), Significant = significant after FDR applied (at $p < 0.05$), Highly significant = significant after FDR applied (at $p < 0.01$);
-ve = negative trend, +ve = positive trend]

Each of these site's trends is discussed more fully in the site section of the report. In general, all but one of the sites that had a significant trend exhibited a broad range of MCI scores across the moving average trendline over the 22-year SEM monitoring period which suggested trends which were ecologically significant. Those sites with the strongest positive improvement over the 22-year monitoring period, coupled with a large increase in MCI scores have been:

- Kaupokonui Stream upstream of Fonterra, Kapuni factory
- Mangaehu River at Raupuha Road
- Punehu Stream at SH45
- Kapoaiaia Stream at Wiremu Road
- Mangawhero Stream upstream of Waingongoro River confluence
- Kaupokonui Stream upstream of Kaponga WWTP
- Kapoaiaia Stream at Wataroa Road
- Mangati Stream at Bell Block
- Timaru Stream at SH45
- Huatoki Stream at Hadley Drive
- Waiongana Stream at SH3
- Mangaoraka Stream at Corbett Road
- Kurapete Stream upstream of Inglewood WWTP
- Waiwhakaiho River at SH 3
- Waingongoro River at Stuart Road
- Waingongoro River at SH45

5 Summary

The 2016-2017 period was the 22nd year of the macroinvertebrate state of the environment monitoring (SEM) programme. Sampling was conducted between October to December 2016 for spring samples and February to March 2017 for summer samples. This report describes the macroinvertebrate communities at 59 sites established through the Taranaki region (TRC, 1995b). These include the additional riparian monitoring sites in the Katikara and Kapoaiaia Streams and the sites in the Maketawa Stream and Waiwhakaiho catchment with the two sites monitored for consent purposes in the Kurapete Stream also included. Sites in the Waiokura Stream and Tangahoe River were also added to the programme in the 2007-2008 period and a site in the lower Herekawe Stream in 2008-2009 (although this site has a lengthy historical consent monitoring record spanning the 1995 to 2008 period). In addition, two new eastern hill country sites were added in the 2015-2016 period in the middle reaches of the Waitara River and lower reaches of the Whenuakura River.

Results are discussed in terms of macroinvertebrate community composition, richness and MCI scores, which are compared with prior SEM data, and stream 'health' is assessed using generic and predictive methodologies. Downstream spatial trends are also identified where possible, and results are discussed in relation to the historical Taranaki streams and river database (TRC 2016b) where applicable and also in relation to more recently established relationships between site altitude and distance from the National Park (Stark and Fowles, 2009) and the REC system (J Leathwick, pers comm.). Discussion of temporal trends over the 22 years of data collection is also provided for each site and causal assessments have been made where trends have been shown to be statistically significant and particularly where ecological importance has been high. Enhancement of stream 'health', particularly in the lower reaches of ringplain catchments (currently mainly in 'fair' condition), may not be expected to be significant and/or important until upstream initiatives (such as diversion to land irrigation of dairy shed wastes and riparian planting/fencing) are substantially implemented throughout catchments.

6 Recommendations from the 2015-2016 report

In the 2015-2016 report, it was recommended:-

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2016-2017 monitoring year by means of the same programme to that undertaken in 2015-2016;
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

These recommendations have been implemented in the 2016-2017 year under review and per this report.

7 Recommendations for 2017-2018

It is recommended for 2017-2018:-

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2017-2018 monitoring year by means of the same programme to that undertaken in 2016-2017;
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

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Appendix I

Macroinvertebrate faunal 2016-2017 tables

Table 130 Macroinvertebrate fauna of the Hangatahua (Stony) River: summer SEM survey sampled on 1 March 2017

Taxa list	Site Code	MCI	STY000300	STY000400
	Sample Number	score	FWB17044	FWB17045
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	C	A
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	-	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	R
	Hydrobiosis	5	-	R
DIPTERA (TRUE FLIES)	*Limonia*	6	R	-
	Maoridiamesa	3	-	R
	Orthocladiinae	2	R	A
		No of taxa	3	6
		MCI	107	100
		SQMCIs	6.9	5.3
		EPT (taxa)	1	4
		%EPT (taxa)	33	67
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 131 Macroinvertebrate fauna of the Herekawe Stream: spring SEM survey sampled 16 February 2017

Taxa list	Site Code		HRK000085
	Sample Number		**FWB17101**
ANNELIDA (WORMS)	Oligochaeta	1	C
	Lumbricidae	5	R
MOLLUSCA	*Potamopyrgus*	4	XA
CRUSTACEA	Ostracoda	1	R
	Paracalliope	5	VA
	Talitridae	5	R
	Paranephrops	5	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A
	Coloburiscus	7	C
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	C
	Zelandobius	5	R
COLEOPTERA (BEETLES)	Elmidae	6	VA
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C
	Hydrobiosis	5	C
	Pycnocentria	7	R
	Pycnocentrodes	5	R
	Triplectides	5	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C
	Maoridiamesa	3	R
	Orthocladiinae	2	R
	Polypedilum	3	R
	Austrosimulium	3	C
	Tanyderidae	4	R
		No of taxa	23
		MCI	92
		SQMCIs	4.5
		EPT (taxa)	9
		%EPT (taxa)	39
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa	

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 132 Macroinvertebrate fauna of the Huatoki Stream: summer SEM survey sampled on 16 February 2017

Taxa List	Site Code / Sample Number	MCI score	HTK000350 FWB17103	HTK000425 FWB17104	HTK000745 FWB17105
ANNELIDA (WORMS)	Oligochaeta	1	C	C	XA
	Lumbricidae	5	-	-	R
MOLLUSCA	*Latia*	5	C	R	R
	Potamopyrgus	4	C	C	VA
	Sphaeriidae	3	-	-	R
CRUSTACEA	*Paranephrops*	5	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	A	R
	Coloburiscus	7	VA	VA	-
	Deleatidium	8	VA	VA	R
	Nesameletus	9	VA	R	-
	Zephlebia group	7	VA	C	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	-	-
	Zelandoperla	8	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	XA
	Ptilodactylidae	8	R	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	A	-
	Costachorema	7	R	R	-
	Hydrobiosis	5	C	R	-
	Neurochorema	6	R	-	-
	Pycnocentria	7	-	R	-
	Pycnocentrodes	5	C	C	R
	Triplectides	5	-	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	R	-
	Eriopterini	5	-	-	C
	Limonia	6	-	-	R
	Harrisius	6	-	-	R
	Maoridiamesa	3	R	-	-
	Orthocladiinae	2	-	R	C
	Polypedilum	3	R	R	-
	Empididae	3	-	-	R
	Austrosimulium	3	C	A	R
	Tanyderidae	4	R	R	C
ACARINA (MITES)	Acarina	5	-	-	R
		No of taxa	24	21	20
		MCI	110	109	97
		SQMCIs	6.6	6.5	3.6
		EPT (taxa)	12	10	5
		%EPT (taxa)	50	48	25
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 133 Macroinvertebrate fauna of the Kapoaiaia Stream: spring SEM survey sampled on 4 October 2016

Taxa List	Site Code / Sample Number	MCI score	KPA000250 FWB16216	KPA000700 FWB16217	KPA000950 FWB16218
NEMERTEA	Nemertea	3	-	R	-
NEMATODA	Nematoda	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	R	A
	Lumbricidae	5	R	-	-
MOLLUSCA	*Potamopyrgus*	4	-	-	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R	R
	Coloburiscus	7	VA	C	-
	Deleatidium	8	XA	XA	A
	Nesameletus	9	A	R	-
	Zephlebia group	7	-	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	-	C	R
	Austroperla	9	C	-	-
	Megaleptoperla	9	R	-	-
	Zelandobius	5	C	A	A
	Zelandoperla	8	A	-	-
COLEOPTERA (BEETLES)	Elmidae	6	C	C	C
	Hydraenidae	8	C	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	C	A
	Costachorema	7	C	C	-
	Hydrobiosis	5	R	R	C
	Psilochorema	6	R	-	-
	Beraeoptera	8	R	R	-
	Helicopsyche	10	A	-	-
	Olinga	9	C	-	-
	Pycnocentrodes	5	A	A	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	R	C
	Maoridiamesa	3	A	C	A
	Orthocladiinae	2	C	C	A
	Tanytarsini	3	-	R	C
	Empididae	3	R	R	R
	Austrosimulium	3	R	-	R
ACARINA (MITES)	Acarina	5	R	R	-
		No of taxa	26	23	18
		MCI	125	107	88
		SQMCIs	7.5	7.5	4.2
		EPT (taxa)	16	12	7
		%EPT (taxa)	62	52	39
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 134 Macroinvertebrate fauna of the Kapoaiaia Stream: summer SEM survey sampled on 3 March 2017

Taxa List	Site Code	MCI	KPA000250	KPA000700	KPA000950
	Sample Number	score	FWB17165	FWB17166	FWB17167
ANNELIDA (WORMS)	Oligochaeta	1	-	C	XA
MOLLUSCA	*Potamopyrgus*	4	-	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C	A
	Coloburiscus	7	C	C	R
	Deleatidium	8	XA	XA	A
	Nesameletus	9	A	R	-
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	C	C
	Hydraenidae	8	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A	VA
	Costachorema	7	C	R	-
	Hydrobiosis	5	R	C	C
	Beraeoptera	8	R	R	-
	Confluens	5	-	R	-
	Oxyethira	2	-	R	-
	Pycnocentrodes	5	R	C	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	VA	VA
	Maoridiamesa	3	VA	A	R
	Orthocladiinae	2	A	C	VA
	Tanytarsini	3	-	C	-
	Empididae	3	R	-	R
	Ephydridae	4	R	-	C
	Muscidae	3	R	C	-
	Austrosimulium	3	-	C	A
		No of taxa	19	20	16
		MCI	115	100	93
		SQMCIs	6.7	7.0	2.4
		EPT (taxa)	10	10	6
		%EPT (taxa)	53	50	38
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 135 Macroinvertebrate fauna of the Katikara Stream: spring SEM survey sampled on 16 February 2017

Taxa List	Site Code / Sample Number	MCI score	KTK000150 FWB17099	KTK000248 FWB17100
ANNELIDA (WORMS)	Oligochaeta	1	-	R
	Lumbricidae	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C
	Coloburiscus	7	C	C
	Deleatidium	8	A	A
	Nesameletus	9	C	-
	Rallidens	9	-	R
	Zephlebia group	7	R	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-
	Spaniocerca	8	R	-
	Zelandobius	5	C	-
	Zelandoperla	8	A	-
COLEOPTERA (BEETLES)	Elmidae	6	R	A
	Hydraenidae	8	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	VA
	Costachorema	7	C	R
	Hydrobiosis	5	R	C
	Hydrobiosella	9	R	-
	Pycnocentrodes	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	C
	Maoridiamesa	3	R	A
	Orthocladiinae	2	C	A
	Tanytarsini	3	-	R
	Austrosimulium	3	-	C
		No of taxa	17	17
		MCI	135	102
		SQMCIs	7.2	4.5
		EPT (taxa)	12	8
		%EPT (taxa)	71	47
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 136 Macroinvertebrate fauna of the Kaupokonui River: spring SEM survey sampled on 19 October 2016

Taxa List	Site Code / Sample Number	MCI score	KPK000250 FWB16240	KPK000500 FWB16241	KPK000660 FWB16248	KPK000880 FWB16251	KPK000990 FWB16242
NEMATODA	Nematoda	3	-	-	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	R	R	R	A	A
	Lumbricidae	5	-	-	-	R	R
MOLLUSCA	*Potamopyrgus*	4	-	-	C	R	A
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-	-	-	-
	Austroclima	7	-	C	R	-	-
	Coloburiscus	7	A	C	VA	C	R
	Deleatidium	8	VA	C	VA	XA	VA
	Nesameletus	9	C	R	C	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R	C	-	R
	Austroperla	9	C	-	-	-	-
	Megaleptoperla	9	C	-	-	-	-
	Stenoperla	10	C	-	-	-	-
	Zelandobius	5	C	-	R	R	C
	Zelandoperla	8	A	-	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	R	A	A	C
	Hydraenidae	8	C	-	R	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	R	A	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	R	A	R	A
	Costachorema	7	R	R	C	-	-
	Hydrobiosis	5	R	C	C	A	A
	Neurochorema	6	-	-	R	-	-
	Psilochorema	6	R	-	-	-	-
	Beraeoptera	8	A	C	C	R	-
	Confluens	5	-	R	R	-	-
	Helicopsyche	10	A	-	-	-	-
	Olinga	9	A	-	C	-	-
	Pycnocentria	7	R	-	-	-	-
	Pycnocentrodes	5	C	C	VA	VA	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A	A	C	C
	Eriopterini	5	R	R	R	-	-
	Maoridiamesa	3	-	A	VA	VA	VA
	Orthocladiinae	2	C	XA	VA	A	A
	Polypedilum	3	C	-	-	-	-
	Tanypodinae	5	-	-	R	-	-
	Tanytarsini	3	-	R	A	A	A
	Empididae	3	R	R	-	-	-
	Austrosimulium	3	-	-	R	-	R
		No of taxa	28	20	26	18	18
		MCI	129	105	109	99	90
		SQMCIs	7.6	2.4	5.1	6.4	4.8
		EPT (taxa)	19	11	14	7	7
		%EPT (taxa)	68	55	54	39	39
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa					

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 137 Macroinvertebrate fauna of the Kaupokonui Stream: summer SEM survey sampled on 10 February 2017

Taxa List	Site Code / Sample Number	MCI score	KPK000250 FWB17027	KPK000500 FWB17028	KPK000660 FWB17036	KPK000880 FWB17039	KPK000990 FWB17031
NEMERTEA	Nemertea	3	-	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	R	R	C	C
MOLLUSCA	*Potamopyrgus*	4	-	C	R	C	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	R	C	R	C
	Coloburiscus	7	A	A	A	-	-
	Deleatidium	8	XA	XA	XA	XA	A
	Nesameletus	9	C	A	C	R	-
	Zephlebia group	7	-	R	-	-	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	-	R	-	-	-
	Megaleptoperla	9	A	R	-	-	-
	Stenoperla	10	C	-	-	-	-
	Taraperla	10	R	-	-	-	-
	Zelandoperla	8	VA	C	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	C	VA	C	R
	Hydraenidae	8	C	R	A	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	A	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	VA	VA	VA	VA
	Costachorema	7	R	A	C	R	R
	Hydrobiosis	5	C	A	C	C	C
	Neurochorema	6	-	R	-	-	-
	Psilochorema	6	R	-	-	-	-
	Beraeoptera	8	-	-	R	-	-
	Helicopsyche	10	R	-	-	-	-
	Olinga	9	VA	C	C	R	R
	Pycnocentrodes	5	-	C	C	C	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	C	R	R	R
	Eriopterini	5	C	R	-	-	-
	Chironomus	1	-	-	R	-	-
	Maoridiamesa	3	-	XA	R	A	A
	Orthocladiinae	2	C	A	R	VA	VA
	Polypedilum	3	R	-	-	-	-
	Tanytarsini	3	-	R	C	C	A
	Empididae	3	-	-	R	R	-
	Muscidae	3	-	R	R	R	R
	Austrosimulium	3	-	R	C	R	-
	Tabanidae	3	-	R	-	-	-
ACARINA (MITES)	Acarina	5	R	-	-	-	R
		No of taxa	22	27	23	20	18
		MCI	136	113	103	102	97
		SQMCIs	7.3	5.4	7.1	6.4	3.7
		EPT (taxa)	14	14	10	8	7
		%EPT (taxa)	64	52	43	40	39
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa					

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 138 Macroinvertebrate fauna of the Kurapete Stream: summer SEM survey sampled on 16 February 2017

Taxa List	Site Code	MCI	KRP000300	KRP000660
	Sample Number	**score**	**FWB17106**	**FWB17107**
ANNELIDA (WORMS)	Oligochaeta	1	VA	C
MOLLUSCA	*Potamopyrgus*	4	A	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A
	Coloburiscus	7	C	C
	Deleatidium	8	-	VA
	Zephlebia group	7	VA	C
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A
	Ptilodactylidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	A
	Costachorema	7	-	C
	Hydrobiosis	5	R	C
	Neurochorema	6	R	R
	Pycnocentrodes	5	R	R
	Triplectides	5	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	A
	Eriopterini	5	R	-
	Hexatomini	5	R	R
	Chironomus	1	R	-
	Maoridiamesa	3	-	R
	Orthocladiinae	2	R	A
	Polypedilum	3	R	R
	Empididae	3	-	R
	Muscidae	3	-	R
	Austrosimulium	3	C	C
	Tanyderidae	4	R	-
ACARINA (MITES)	Acarina	5	R	-
		No of taxa	22	21
		MCI	98	96
		SQMCIs	4.4	6.1
		EPT (taxa)	9	9
		%EPT (taxa)	41	43
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 139 Macroinvertebrate fauna of the Maketawa Stream: SEM spring survey sampled on 15 February 2017

Taxa List	Site Code / Sample Number	MCI score	MKW000200 FWB17083	MKW000300 FWB17084
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	-	C
	Deleatidium	8	XA	XA
	Nesameletus	9	A	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	-	R
	Megaleptoperla	9	C	R
	Stenoperla	10	R	-
	Zelandoperla	8	A	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
	Hydraenidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	A
	Costachorema	7	A	C
	Hydrobiosis	5	C	R
	Hydropsyche (Orthopsyche)	9	R	-
	Plectrocnemia	8	R	-
	Psilochorema	6	R	R
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A
	Maoridiamesa	3	-	R
	Orthocladiinae	2	R	C
	Polypedilum	3	-	R
	Tanytarsini	3	-	R
	Empididae	3	-	R
	Austrosimulium	3	-	C
		No of taxa	13	20
		MCI	142	112
		SQMCIs	7.7	7.5
		EPT (taxa)	10	10
		%EPT (taxa)	77	50
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 140 Macroinvertebrate fauna of the Mangaehu River: spring SEM survey sampled on 4 November 2016 and summer SEM survey sampled on 7 March 2017

Taxa List	Site Code / Sample Number	MCI score	MGH000950 FWB16258	MGH000950 FWB17186
NEMERTEA	Nemertea	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	C
	Lumbricidae	5	-	R
MOLLUSCA	*Potamopyrgus*	4	C	A
CRUSTACEA	*Paracalliope*	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C
	Deleatidium	8	-	R
	Mauiulus	5	-	R
	Zephlebia group	7	-	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-
	Zelandobius	5	R	-
COLEOPTERA (BEETLES)	Elmidae	6	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	A
	Hydrobiosis	5	C	C
	Oxyethira	2	-	R
	Pycnocentria	7	-	C
	Pycnocentrodes	5	C	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	VA
	Maoridiamesa	3	C	A
	Orthocladiinae	2	VA	A
	Tanytarsini	3	-	A
	Empididae	3	R	R
		No of taxa	12	21
		MCI	92	92
		SQMCIs	2.8	4.5
		EPT (taxa)	6	8
		%EPT (taxa)	50	38
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 141 Macroinvertebrate fauna of the Manganui River: spring SEM survey sampled on 2 December 2016

Taxa List	Site Code / Sample Number	MCI score	MGN000195 FWB16326	MGN000427 FWB16327
ANNELIDA (WORMS)	Oligochaeta	1	-	R
CRUSTACEA	Talitridae	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R
	Coloburiscus	7	-	R
	Deleatidium	8	VA	XA
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	R	-
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	C
	Costachorema	7	C	C
	Hydrobiosis	5	-	C
	Psilochorema	6	R	-
	Oxyethira	2	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A
	Maoridiamesa	3	-	A
	Orthocladiinae	2	C	VA
	Austrosimulium	3	-	C
		No of taxa	9	14
		MCI	124	96
		SQMCIs	7.4	6.7
		EPT (taxa)	5	6
		%EPT (taxa)	56	43
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 142 Macroinvertebrate fauna of the Manganui River: summer SEM survey sampled on 23 February 2017

Taxa List	Site Code / Sample Number	MCI score	MGN000195 FWB17114	MGN000427 FWB17115
ANNELIDA (WORMS)	Oligochaeta	1	R	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R
	Coloburiscus	7	-	R
	Deleatidium	8	VA	VA
	Nesameletus	9	C	R
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	C	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A
	Costachorema	7	C	C
	Hydrobiosis	5	-	C
	Neurochorema	6	-	C
	Psilochorema	6	R	-
	Confluens	5	-	R
	Oxyethira	2	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	R	-
	Maoridiamesa	3	-	VA
	Orthocladiinae	2	R	VA
	Polypedilum	3	R	-
	Tanytarsini	3	-	C
	Empididae	3	-	R
	Muscidae	3	-	R
	Austrosimulium	3	R	C
		No of taxa	14	20
		MCI	106	96
		SQMCIs	7.3	4.5
		EPT (taxa)	6	9
		%EPT (taxa)	43	45
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 143 Macroinvertebrate fauna of the Mangaoraka Stream: summer SEM survey sampled on 15 February 2017

Taxa List	Site Code / Sample Number	MCI score	MRK000420 / FWB17081
ANNELIDA (WORMS)	Oligochaeta	1	C
MOLLUSCA	*Potamopyrgus*	4	VA
CRUSTACEA	*Paracalliope*	5	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C
	Deleatidium	8	C
	Zephlebia group	7	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R
COLEOPTERA (BEETLES)	Elmidae	6	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A
	Hydrobiosis	5	C
	Neurochorema	6	R
	Pycnocentria	7	R
	Pycnocentrodes	5	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A
	Maoridiamesa	3	C
	Orthocladiinae	2	C
	Tanytarsini	3	R
	Empididae	3	R
	Austrosimulium	3	R
ACARINA (MITES)	Acarina	5	R
		No of taxa	21
		MCI	96
		SQMCIs	4.6
		EPT (taxa)	9
		%EPT (taxa)	43
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa	

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 144 Macroinvertebrate fauna of the Mangati Stream: summer SEM survey sampled on 1 March 2017

Taxa List	Site Code Sample Number	MCI score	MGT000488 FWB17144	MGT000520 FWB17150
COELENTERATA	Coelenterata	3	-	R
NEMERTEA	Nemertea	3	C	C
ANNELIDA (WORMS)	Oligochaeta	1	VA	XA
	Lumbricidae	5	-	C
HIRUDINEA (LEECHES)	Hirudinea	3	R	-
MOLLUSCA	*Physa*	3	R	-
	Potamopyrgus	4	XA	XA
	Sphaeriidae	3	R	-
CRUSTACEA	Ostracoda	1	XA	-
	Isopoda	5	R	-
	Paracalliope	5	XA	-
	Talitridae	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	-
TRICHOPTERA (CADDISFLIES)	*Oxyethira*	2	-	C
	Triplectides	5	R	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	R
	Limonia	6	-	R
	Orthocladiinae	2	A	A
	Polypedilum	3	VA	-
	Paradixa	4	R	-
	Empididae	3	-	C
	Austrosimulium	3	A	C
ACARINA (MITES)	Acarina	5	C	R
		No of taxa	17	13
		MCI	73	72
		SQMCIs	3.2	2.5
		EPT (taxa)	2	1
		%EPT (taxa)	12	8
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 145 Macroinvertebrate fauna of the Mangawhero Stream: spring SEM survey sampled on 18 October 2016

Taxa List	Site Code / Sample Number	MCI score	MWH000380 FWB16235	MWH000490 FWB16236
NEMERTEA	Nemertea	3	R	-
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	VA	A
	Lumbricidae	5	-	R
MOLLUSCA	*Ferrissia*	3	-	R
	Potamopyrgus	4	A	C
CRUSTACEA	*Paracalliope*	5	C	C
	Paranephrops	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R
	Deleatidium	8	-	A
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C	C
COLEOPTERA (BEETLES)	Elmidae	6	-	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A
	Hydrobiosis	5	C	C
	Neurochorema	6	-	R
	Oxyethira	2	R	-
	Pycnocentria	7	-	C
	Pycnocentrodes	5	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Maoridiamesa	3	-	C
	Orthocladiinae	2	C	A
	Polypedilum	3	R	A
	Tanytarsini	3	-	A
	Empididae	3	R	R
	Austrosimulium	3	C	R
		No of taxa	14	24
		MCI	74	90
		SQMCIs	2.3	4.1
		EPT (taxa)	4	8
		%EPT (taxa)	29	33
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 146 Macroinvertebrate fauna of the Mangawhero Stream: summer SEM survey sampled on 14 February 2017

Taxa List	Site Code	MCI	MWH000380	MWH000490
	Sample Number	score	FWB17060	FWB17061
NEMERTEA	Nemertea	3	-	C
ANNELIDA (WORMS)	Oligochaeta	1	R	C
	Lumbricidae	5	R	-
MOLLUSCA	*Physa*	3	-	R
	Potamopyrgus	4	VA	VA
CRUSTACEA	Ostracoda	1	C	R
	Paracalliope	5	XA	VA
	Talitridae	5	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	-
	Coloburiscus	7	R	-
	Deleatidium	8	R	-
	Zephlebia group	7	C	-
COLEOPTERA (BEETLES)	Elmidae	6	-	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	VA
	Costachorema	7	-	R
	Hydrobiosis	5	C	C
	Oxyethira	2	R	R
	Paroxyethira	2	R	-
	Pycnocentria	7	-	C
	Pycnocentrodes	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	R
	Chironomus	1	R	-
	Maoridiamesa	3	R	C
	Orthocladiinae	2	A	A
	Polypedilum	3	R	-
	Tanytarsini	3	R	A
	Empididae	3	-	C
	Muscidae	3	R	C
	Austrosimulium	3	VA	-
		No of taxa	21	21
		MCI	77	80
		SQMCIs	4.5	4.2
		EPT (taxa)	6	5
		%EPT (taxa)	29	24
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 147 Macroinvertebrate fauna of the Mangorei Stream: summer SEM survey sampled on 24 February 2017

Taxa List	Site Code / Sample Number	MCI score	MGE000970 / FWB17116
NEMERTEA	Nemertea	3	R
ANNELIDA (WORMS)	Oligochaeta	1	C
MOLLUSCA	*Potamopyrgus*	4	C
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R
	Austroclima	7	C
	Coloburiscus	7	C
	Deleatidium	8	VA
	Nesameletus	9	R
	Zephlebia group	7	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C
	Zelandoperla	8	R
COLEOPTERA (BEETLES)	Elmidae	6	A
	Hydraenidae	8	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA
	Hydrobiosis	5	C
	Neurochorema	6	C
	Confluens	5	R
	Oxyethira	2	A
	Pycnocentrodes	5	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA
	Maoridiamesa	3	A
	Orthocladiinae	2	A
	Polypedilum	3	R
	Tanypodinae	5	R
	Tanytarsini	3	C
	Empididae	3	R
	Muscidae	3	R
	Austrosimulium	3	VA
	Tanyderidae	4	R
		No of taxa	30
		MCI	101
		SQMCIs	4.8
		EPT (taxa)	13
		%EPT (taxa)	43
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa	

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 148 Macroinvertebrate fauna of the Patea River: spring SEM survey sampled on 18 December 2016

Taxa List	Site Code Sample Number	MCI score	PAT000200 FWB16301	PAT000315 FWB16302	PAT000360 FWB16305
NEMATODA	Nematoda	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	R	C	XA
	Lumbricidae	5	R	-	-
MOLLUSCA	*Potamopyrgus*	4	-	C	R
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-	-
	Austroclima	7	C	R	-
	Coloburiscus	7	A	VA	C
	Deleatidium	8	XA	XA	A
	Nesameletus	9	R	A	R
	Zephlebia group	7	-	C	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-	-
	Megaleptoperla	9	C	-	-
	Spaniocerca	8	R	-	-
	Stenoperla	10	R	R	-
	Zelandobius	5	C	-	R
	Zelandoperla	8	A	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	C	C
	Hydraenidae	8	C	C	R
	Hydrophilidae	5	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	A	A
	Costachorema	7	R	R	C
	Hydrobiosis	5	-	R	C
	Hydrobiosella	9	C	-	-
	Hydropsyche (Orthopsyche)	9	C	-	-
	Psilochorema	6	R	-	-
	Beraeoptera	8	C	R	-
	Olinga	9	C	R	-
	Pycnocentria	7	R	-	-
	Pycnocentrodes	5	-	C	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C	A
	Eriopterini	5	R	-	-
	Chironomus	1	-	-	R
	Maoridiamesa	3	-	R	VA
	Orthocladiinae	2	C	C	C
	Polypedilum	3	-	R	-
	Tanytarsini	3	-	-	A
	Austrosimulium	3	-	R	R
		No of taxa	27	22	20
		MCI	140	116	96
		SQMCIs	7.8	7.6	1.9
		EPT (taxa)	18	12	8
		%EPT (taxa)	67	55	40
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 149 Macroinvertebrate fauna of the Patea River: summer SEM survey sampled on 22 March 2017

Taxa List	Site Code	MCI	PAT000200	PAT000315	PAT000360
	Sample Number	score	FWB17201	FWB17202	FWB17207
ANNELIDA (WORMS)	Oligochaeta	1	-	R	C
MOLLUSCA	*Potamopyrgus*	4	-	R	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C	R
	Coloburiscus	7	A	VA	C
	Deleatidium	8	VA	VA	C
	Nesameletus	9	R	VA	-
	Zephlebia group	7	R	R	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-	-
	Megaleptoperla	9	C	-	-
	Spaniocerca	8	R	-	-
	Stenoperla	10	R	-	-
	Taraperla	10	C	-	-
	Zelandoperla	8	A	R	-
HEMIPTERA (BUGS)	*Sigara*	3	-	-	R
COLEOPTERA (BEETLES)	Elmidae	6	A	A	A
	Hydraenidae	8	C	C	C
	Hydrophilidae	5	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	VA	VA
	Costachorema	7	R	C	C
	Hydrobiosis	5	C	R	C
	Hydrobiosella	9	R	-	-
	Neurochorema	6	-	C	R
	Hydropsyche (Orthopsyche)	9	A	-	-
	Psilochorema	6	R	-	-
	Beraeoptera	8	C	VA	R
	Confluens	5	-	-	C
	Helicopsyche	10	R	-	-
	Olinga	9	C	-	-
	Oxyethira	2	-	-	R
	Pycnocentria	7	C	-	R
	Pycnocentrodes	5	-	C	A
	Triplectides	5	-	R	R
	Zelolessica	7	A	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C	R
	Hexatomini	5	-	-	R
	Maoridiamesa	3	-	-	A
	Orthocladiinae	2	R	-	A
	Tanytarsini	3	-	-	A
	Dolichopodidae	3	-	-	R
	Empididae	3	-	-	R
	Muscidae	3	-	R	A
	Austrosimulium	3	-	-	R
		No of taxa	27	20	28
		MCI	150	120	96
		SQMCIs	7.7	7.1	4.2
		EPT (taxa)	21	13	12
		%EPT (taxa)	78	65	43
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 150 Macroinvertebrate fauna of the Punehu Stream: spring SEM survey sampled on 19 October 2016

Taxa List	Site Code	MCI	PNH000200	PNH000900
	Sample Number	score	FWB16243	FWB16244
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	C	A
	Lumbricidae	5	-	R
MOLLUSCA	*Potamopyrgus*	4	C	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	R
	Coloburiscus	7	VA	R
	Deleatidium	8	XA	C
	Nesameletus	9	A	-
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	R	-
	Zelandobius	5	C	-
COLEOPTERA (BEETLES)	Elmidae	6	A	R
	Hydraenidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	C
	Costachorema	7	R	-
	Hydrobiosis	5	R	R
	Beraeoptera	8	VA	R
	Helicopsyche	10	C	-
	Olinga	9	C	-
	Pycnocentrodes	5	VA	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	R
	Eriopterini	5	-	R
	Maoridiamesa	3	C	R
	Orthocladiinae	2	C	A
	Polypedilum	3	-	C
	Tanytarsini	3	-	R
ACARINA (MITES)	Acarina	5	-	R
		No of taxa	21	20
		MCI	123	96
		SQMCIs	7.3	3.3
		EPT (taxa)	13	7
		%EPT (taxa)	62	35
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 151 Macroinvertebrate fauna of the Punehu Stream: summer SEM survey sampled on 8 March 2017

Taxa List	Site Code Sample Number	MCI score	PNH000200 FWB17193	PNH000900 FWB17194
ANNELIDA (WORMS)	Oligochaeta	1	-	VA
CRUSTACEA	Ostracoda	1	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	A
	Coloburiscus	7	R	A
	Deleatidium	8	VA	VA
	Nesameletus	9	VA	-
	Zephlebia group	7	-	R
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	R	-
	Zelandoperla	8	C	-
COLEOPTERA (BEETLES)	Elmidae	6	A	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	VA
	Costachorema	7	C	R
	Hydrobiosis	5	C	A
	Plectrocnemia	8	R	-
	Olinga	9	C	-
	Oxyethira	2	-	C
	Pycnocentrodes	5	C	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Maoridiamesa	3	VA	A
	Orthocladiinae	2	VA	VA
	Polypedilum	3	-	A
	Tanytarsini	3	-	A
	Dolichopodidae	3	-	R
	Empididae	3	-	R
	Ephydridae	4	-	R
	Muscidae	3	-	R
	Austrosimulium	3	-	A
ACARINA (MITES)	Acarina	5	R	R
		No of taxa	18	24
		MCI	127	87
		SQMCIs	5.6	4.0
		EPT (taxa)	12	8
		%EPT (taxa)	67	33
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 152 Macroinvertebrate fauna of the Tangahoe River: spring SEM survey sampled on 14 December 2016

Taxa List	Site Code / Sample Number	MCI score	TNH000090 FWB16291	TNH000200 FWB16292	TNH000515 FWB16293
ANNELIDA (WORMS)	Oligochaeta	1	C	-	A
	Lumbricidae	5	-	-	R
MOLLUSCA	*Potamopyrgus*	4	A	A	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	XA	VA	A
	Coloburiscus	7	-	-	R
	Deleatidium	8	XA	A	A
	Rallidens	9	C	R	-
	Zephlebia group	7	A	R	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-	-
	Zelandobius	5	R	R	R
COLEOPTERA (BEETLES)	Elmidae	6	A	A	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	R	VA
	Hydrobiosis	5	C	C	C
	Oxyethira	2	-	R	-
	Pycnocentrodes	5	-	R	VA
	Triplectides	5	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	C	A
	Eriopterini	5	R	-	R
	Maoridiamesa	3	R	R	VA
	Orthocladiinae	2	C	A	C
	Polypedilum	3	-	-	C
	Tanytarsini	3	-	R	R
	Paradixa	4	R	-	-
	Austrosimulium	3	A	C	R
		No of taxa	17	17	20
		MCI	98	100	95
		SQMCIs	7.2	5.9	4.6
		EPT (taxa)	9	8	8
		%EPT (taxa)	53	47	40
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 153 Macroinvertebrate fauna of the Tangahoe River: summer SEM survey sampled on 20 March 2017

Taxa List	Site Code	MCI	TNH000090	TNH000200	TNH000515
	Sample Number	score	FWB17196	FWB17197	FWB17198
NEMERTEA	Nemertea	3	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	C	C	C
	Lumbricidae	5	-	R	-
MOLLUSCA	*Latia*	5	-	-	R
	Potamopyrgus	4	VA	VA	VA
CRUSTACEA	*Paracalliope*	5	-	-	R
	Phreatogammarus	5	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	VA	C
	Coloburiscus	7	R	C	R
	Deleatidium	8	VA	VA	-
	Oniscigaster	10	R	-	-
	Rallidens	9	-	R	-
	Zephlebia group	7	C	A	-
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	C	-	-
	Zelandobius	5	R	C	-
	Zelandoperla	8	-	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	VA	VA
	Hydraenidae	8	R	R	-
	Hydrophilidae	5	R	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	A	XA
	Costachorema	7	-	R	-
	Hydrobiosis	5	R	R	A
	Neurochorema	6	-	R	R
	Beraeoptera	8	-	R	-
	Oxyethira	2	R	-	-
	Pycnocentria	7	-	C	-
	Pycnocentrodes	5	-	C	XA
	Triplectides	5	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C	A
	Eriopterini	5	R	-	-
	Hexatomini	5	R	-	-
	Maoridiamesa	3	R	-	A
	Orthocladiinae	2	-	C	A
	Polypedilum	3	-	R	C
	Tanytarsini	3	-	A	A
	Paradixa	4	R	-	-
	Muscidae	3	-	-	R
	Austrosimulium	3	VA	C	R
	Tanyderidae	4	R	R	-
		No of taxa	25	27	20
		MCI	106	110	89
		SQMCIs	5.5	5.9	4.5
		EPT (taxa)	10	14	6
		%EPT (taxa)	40	52	30
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 154 Macroinvertebrate fauna of the Timaru Stream: summer SEM survey sampled on 17 February 2017

Taxa List	Site Code / Sample Number	MCI score	TMR000150 FWB17040	TMR000375 FWB17041
ANNELIDA (WORMS)	Oligochaeta	1	-	R
	Lumbricidae	5	-	R
MOLLUSCA	*Potamopyrgus*	4	-	A
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-
	Austroclima	7	R	A
	Coloburiscus	7	A	A
	Deleatidium	8	VA	A
	Nesameletus	9	A	-
	Rallidens	9	-	R
	Zephlebia group	7	-	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-
	Megaleptoperla	9	R	-
	Stenoperla	10	C	-
	Zelandobius	5	A	R
	Zelandobius illiesi	10	R	-
	Zelandoperla	8	VA	R
COLEOPTERA (BEETLES)	Elmidae	6	C	A
	Hydraenidae	8	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	A
	Costachorema	7	C	C
	Hydrobiosis	5	R	C
	Hydrobiosella	9	R	-
	Neurochorema	6	-	A
	Hydropsyche (Orthopsyche)	9	R	-
	Beraeoptera	8	C	R
	Confluens	5	-	R
	Olinga	9	R	-
	Pycnocentrodes	5	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	VA
	Eriopterini	5	-	R
	Maoridiamesa	3	-	A
	Orthocladiinae	2	C	A
	Tanytarsini	3	-	R
	Austrosimulium	3	-	R
		No of taxa	22	26
		MCI	152	110
		SQMCIs	7.6	5.3
		EPT (taxa)	17	14
		%EPT (taxa)	77	54
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 155 Macroinvertebrate fauna of the Waiau Stream: spring SEM survey sampled on 15 February 2017

Taxa List	Site Code	MCI	WAI000110
	Sample Number	score	FWB17082
NEMERTEA	Nemertea	3	R
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Latia*	5	R
	Potamopyrgus	4	XA
CRUSTACEA	*Paracalliope*	5	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R
COLEOPTERA (BEETLES)	Elmidae	6	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA
	Hydrobiosis	5	C
	Hudsonema	6	R
	Pycnocentria	7	C
	Pycnocentrodes	5	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C
	Maoridiamesa	3	R
	Orthocladiinae	2	R
		No of taxa	17
		MCI	94
		SQMCIs	4.3
		EPT (taxa)	7
		%EPT (taxa)	41
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa	

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 156 Macroinvertebrate fauna of the Waimoku Stream: spring SEM survey sampled on 14 February 2017

Taxa List	Site Code Sample Number	MCI score	WMK000100 FWB17042	WMK000298 FWB17043
NEMERTEA	Nemertea	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	C
	Lumbricidae	5	-	R
MOLLUSCA	*Latia*	5	-	R
	Potamopyrgus	4	C	XA
	Sphaeriidae	3	-	C
CRUSTACEA	Talitridae	5	R	-
	Paratya	3	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	A
	Coloburiscus	7	VA	C
	Deleatidium	8	A	-
	Ichthybotus	8	R	-
	Nesameletus	9	C	-
	Zephlebia group	7	A	A
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-
	Megaleptoperla	9	R	-
	Spaniocerca	8	R	-
	Stenoperla	10	C	-
	Zelandobius	5	-	R
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	C	A
	Hydraenidae	8	R	-
	Ptilodactylidae	8	C	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	-
	Costachorema	7	R	-
	Hydrobiosis	5	R	C
	Hydrobiosella	9	C	-
	Hydrochorema	9	R	-
	Hydropsyche (Orthopsyche)	9	VA	R
	Helicopsyche	10	R	-
	Olinga	9	-	R
	Oxyethira	2	-	C
	Pycnocentria	7	R	R
	Pycnocentrodes	5	-	A
	Triplectides	5	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	VA
	Eriopterini	5	R	R
	Hexatomini	5	R	-
	Chironomus	1	-	R
	Maoridiamesa	3	R	C
	Orthocladiinae	2	C	A
	Polypedilum	3	-	C
	Empididae	3	R	-
	Austrosimulium	3	-	C
	Tanyderidae	4	-	C
ACARINA (MITES)	Acarina	5	-	R
		No of taxa	30	29
		MCI	137	94
		SQMCIs	7.5	4.3
		EPT (taxa)	19	10
		%EPT (taxa)	63	34
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 157 Macroinvertebrate fauna of the Waingongoro River: spring SEM survey sampled on 18 October 2016

Taxa List	Site Code	MCI score	WGG000115	WGG000150	WGG000500	WGG000665	WGG000895	WGG000995
	Sample Number		FWB16230	FWB16231	FWB16232	FWB16237	FWB16238	FWB16239
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	-	-	-	R	-
NEMATODA	Nematoda	3	-	-	R	-	-	-
ANNELIDA (WORMS)	Oligochaeta	1	R	R	R	R	A	VA
	Lumbricidae	5	-	-	-	-	R	-
MOLLUSCA	*Potamopyrgus*	4	-	-	R	-	A	A
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	R	-	-	-	-	-
	Ameletopsis	10	R	-	-	-	-	-
	Austroclima	7	-	C	R	-	-	R
	Coloburiscus	7	A	VA	A	-	-	-
	Deleatidium	8	XA	VA	VA	VA	A	C
	Nesameletus	9	A	R	R	-	-	-
	Zephlebia group	7	-	-	R	R	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	-	-	-	-	-
	Austroperla	9	R	-	-	-	-	-
	Megaleptoperla	9	R	-	-	-	-	-
	Stenoperla	10	C	-	-	-	-	-
	Zelandobius	5	A	R	C	R	R	C
	Zelandoperla	8	VA	A	-	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	A	R	C	A
	Hydraenidae	8	C	C	-	-	-	-
	Staphylinidae	5	R	-	-	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	C	R	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	C	C	C	R	R
	Costachorema	7	R	-	-	-	-	-
	Hydrobiosis	5	-	R	C	C	R	R
	Hydrobiosella	9	R	-	-	-	-	-
	Hydropsyche (Orthopsyche)	9	R	-	-	-	-	-
	Psilochorema	6	R	-	-	-	-	-
	Beraeoptera	8	A	A	R	-	-	-
	Confluens	5	-	R	-	-	-	-
	Helicopsyche	10	A	R	-	-	-	-
	Olinga	9	A	R	-	-	-	-
	Pycnocentria	7	-	-	-	R	R	-
	Pycnocentrodes	5	R	C	A	C	A	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	C	-	R	-	R
	Eriopterini	5	-	C	R	-	R	-
	Maoridiamesa	3	R	-	-	R	-	A
	Orthocladiinae	2	R	-	C	C	-	A
	Polypedilum	3	R	R	-	-	-	-
	Tanypodinae	5	R	R	-	-	-	-
	Tanytarsini	3	R	-	C	-	-	R
	Dolichopodidae	3	R	-	-	-	-	-
	Empididae	3	R	R	R	-	-	-
	Ephydridae	4	-	-	-	-	-	R
	Austrosimulium	3	-	-	C	-	C	R
	Tanyderidae	4	-	-	R	-	-	-
		No of taxa	32	22	21	14	14	16
		MCI	129	121	101	104	97	90
		SQMCIs	7.8	7.2	6.6	7.2	4.6	3.4
		EPT (taxa)	19	13	10	8	6	6
		%EPT (taxa)	59	59	48	57	43	38
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa						

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 158 Macroinvertebrate fauna of the Waingongoro River: summer SEM survey sampled on 14 February 2017

Taxa List	Site Code	MCI	WGG000115	WGG000150	WGG000500	WGG000665	WGG000895	WGG000995
	Sample Number	score	FWB17050	FWB17051	FWB17052	FWB17057	FWB17058	FWB17059
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	-	-	-	-	R
NEMERTEA	Nemertea	3	-	-	R	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R	R	A	C
	Lumbricidae	5	-	-	-	-	C	-
MOLLUSCA	*Echyridella*	3	-	-	-	-	R	-
	Latia	5	-	-	-	-	-	C
	Physa	3	-	-	-	-	R	R
	Potamopyrgus	4	R	R	C	C	VA	XA
	Sphaeriidae	3	-	-	-	-	R	-
CRUSTACEA	*Paracalliope*	5	-	-	-	-	C	R
	Paratya	3	-	-	-	-	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	A	R	R	C	C
	Coloburiscus	7	A	A	A	R	-	R
	Deleatidium	8	VA	VA	XA	VA	A	C
	Nesameletus	9	C	A	C	R	-	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	R	-	-	-	-
	Megaleptoperla	9	A	R	-	-	-	-
	Stenoperla	10	C	-	-	-	-	-
	Zelandobius	5	R	-	R	-	-	R
	Zelandoperla	8	VA	A	R	-	-	-
HEMIPTERA (BUGS)	*Anisops*	5	-	-	-	-	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	A	R	A	A
	Hydraenidae	8	C	C	C	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	C	C	C	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	A	VA	VA	VA	XA
	Costachorema	7	R	R	R	C	-	-
	Hydrobiosis	5	C	C	C	C	C	-
	Neurochorema	6	-	-	-	-	R	-
	Plectrocnemia	8	R	-	-	-	-	-
	Beraeoptera	8	R	-	-	-	-	-
	Confluens	5	-	R	-	-	-	-
	Hudsonema	6	-	-	-	-	C	-
	Olinga	9	A	R	-	-	-	-
	Oxyethira	2	-	-	-	-	R	R
	Pycnocentrodes	5	-	-	R	R	VA	VA
	Zelolessica	7	-	R	-	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A	R	A	R	R
	Eriopterini	5	R	-	-	-	-	-
	Maoridiamesa	3	-	-	-	VA	-	-
	Orthocladiinae	2	C	R	C	A	R	A
	Polypedilum	3	C	R	-	-	-	C
	Tanytarsini	3	-	-	R	A	R	C
	Empididae	3	-	-	R	C	-	R
	Ephydridae	4	-	-	-	-	-	R
	Muscidae	3	-	-	-	R	-	R
	Austrosimulium	3	-	R	R	-	R	R
	Tanyderidae	4	-	R	R	R	-	-
		No of taxa	23	22	22	20	23	25
		MCI	133	124	104	101	88	83
		SQMCIs	7.7	7.1	7.2	4.8	4.5	4.1
		EPT (taxa)	15	13	10	8	7	6
		%EPT (taxa)	65	59	45	40	30	24
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa						

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 159 Macroinvertebrate fauna of the Waiokura Stream:spring SEM survey sampled on 19 October 2016

Taxa List	Site Code	MCI	WKR000500	WKR000700
	Sample Number	score	FWB16245	FWB16246
ANNELIDA (WORMS)	Oligochaeta	1	C	C
MOLLUSCA	*Potamopyrgus*	4	C	C
CRUSTACEA	Ostracoda	1	-	R
	Paraleptamphopidae	5	R	R
	Talitridae	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	VA
	Coloburiscus	7	C	A
	Deleatidium	8	R	R
	Zephlebia group	7	A	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	A	A
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	A
	Costachorema	7	R	-
	Ecnomidae/Psychomyiidae	6	R	-
	Hydrobiosis	5	-	C
	Hydropsyche (Orthopsyche)	9	C	-
	Psilochorema	6	R	R
	Helicopsyche	10	R	-
	Hudsonema	6	C	-
	Oecetis	4	R	R
	Pycnocentria	7	C	C
	Pycnocentrodes	5	C	R
	Triplectides	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	R
	Eriopterini	5	R	-
	Polypedilum	3	-	R
	Tanytarsini	3	A	R
	Dolichopodidae	3	-	R
	Empididae	3	R	-
	Austrosimulium	3	R	-
	Tanyderidae	4	R	-
		No of taxa	25	23
		MCI	111	98
		SQMCIs	6.0	6.4
		EPT (taxa)	15	12
		%EPT (taxa)	60	52
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 160 Macroinvertebrate fauna of the Waiokura Stream: summer SEM survey sampled on 10 February 2017

Taxa List	Site Code / Sample Number	MCI score	WKR000500 FWB17032	WKR000700 FWB17034
ANNELIDA (WORMS)	Oligochaeta	1	A	A
MOLLUSCA	*Potamopyrgus*	4	C	R
CRUSTACEA	Ostracoda	1	A	C
	Paracalliope	5	A	A
	Paraleptamphopidae	5	R	-
	Paranephrops	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	C
	Coloburiscus	7	C	C
	Deleatidium	8	-	R
	Zephlebia group	7	A	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	VA
	Hydrobiosis	5	-	R
	Psilochorema	6	R	C
	Oecetis	4	-	R
	Pycnocentrodes	5	R	-
	Triplectides	5	C	R
DIPTERA (TRUE FLIES)	*Chironomus*	1	R	-
	Harrisius	6	R	-
	Orthocladiinae	2	-	C
	Polypedilum	3	-	R
	Austrosimulium	3	-	C
	Tanyderidae	4	-	C
ACARINA (MITES)	Acarina	5	C	-
		No of taxa	19	19
		MCI	97	94
		SQMCIs	5.5	5.2
		EPT (taxa)	8	9
		%EPT (taxa)	42	47
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 161 Macroinvertebrate fauna of the Waiongana Stream: summer SEM survey sampled on 15 February 2017

Taxa List	Site Code / Sample Number	MCI score	WGA000260 FWB17085	WGA000450 FWB17086
ANNELIDA (WORMS)	Oligochaeta	1	R	C
	Lumbricidae	5	R	R
MOLLUSCA	*Potamopyrgus*	4	C	C
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	R	-
	Deleatidium	8	VA	C
	Nesameletus	9	R	-
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	-	R
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	C
	Costachorema	7	C	R
	Hydrobiosis	5	C	C
	Neurochorema	6	R	-
	Pycnocentrodes	5	R	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	R
	Maoridiamesa	3	A	C
	Orthocladiinae	2	A	A
	Polypedilum	3	-	R
	Tanytarsini	3	C	C
	Empididae	3	R	R
	Austrosimulium	3	C	C
	Tanyderidae	4	R	-
		No of taxa	21	18
		MCI	100	88
		SQMCIs	5.9	3.9
		EPT (taxa)	9	6
		%EPT (taxa)	43	33
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 162 Macroinvertebrate fauna of the Waitara River: spring SEM survey sampled on 9 December 2016

Taxa List	Site Code	MCI	WTR000540	WTR000850
	Sample Number	score	FWB16273	FWB16274
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	A	R
	Branchiura	1	R	-
	Lumbricidae	5	-	R
MOLLUSCA	*Latia*	5	C	-
	Potamopyrgus	4	XA	C
CRUSTACEA	*Paracalliope*	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	-
	Coloburiscus	7	R	R
	Deleatidium	8	A	A
	Rallidens	9	R	-
	Zephlebia group	7	C	-
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	R
COLEOPTERA (BEETLES)	Elmidae	6	A	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A
	Costachorema	7	-	R
	Hydrobiosis	5	C	R
	Neurochorema	6	R	-
	Oxyethira	2	R	-
	Pycnocentria	7	R	-
	Pycnocentrodes	5	A	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	-
	Orthocladiinae	2	C	A
	Polypedilum	3	-	R
	Tanytarsini	3	R	-
	Empididae	3	R	-
	Austrosimulium	3	C	R
	Tanyderidae	4	R	-
		No of taxa	26	14
		MCI	95	96
		SQMCIs	4.3	4.7
		EPT (taxa)	11	6
		%EPT (taxa)	42	43
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 163 Macroinvertebrate fauna of the Waitara River: summer SEM survey sampled on 1 March 2017

Taxa list	Site Code	MCI	WTR000540	WTR000850
	Sample Number	score	FWB17142	FWB17143
ANNELIDA (WORMS)	Oligochaeta	1	C	C
MOLLUSCA	*Latia*	5	R	-
	Potamopyrgus	4	VA	-
CRUSTACEA	*Paratya*	3	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	-
	Deleatidium	8	A	C
	Zephlebia group	7	C	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	XA
	Costachorema	7	R	R
	Hydrobiosis	5	C	-
	Oxyethira	2	-	R
	Pycnocentria	7	R	-
	Pycnocentrodes	5	C	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A
	Eriopterini	5	R	-
	Maoridiamesa	3	-	C
	Orthocladiinae	2	C	A
	Tanytarsini	3	-	A
	Empididae	3	-	R
	Austrosimulium	3	R	R
	Tanyderidae	4	R	R
		No of taxa	19	16
		MCI	102	85
		SQMCIs	4.8	4.0
		EPT (taxa)	9	4
		%EPT (taxa)	47	25
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 164 Macroinvertebrate fauna of the Waiwhakaiho River: spring SEM survey sampled on 15 February 2017

Taxa list	Site Code	MCI	WKH000100	WKH000500	WKH000920	WKH000950
	Sample Number	score	FWB17089	FWB17088	FWB17071	FWB17073
NEMERTEA	Nemertea	3	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R	R
MOLLUSCA	*Melanopsis*	3	-	-	-	R
	Potamopyrgus	4	-	-	-	R
CRUSTACEA	*Paratya*	3	-	-	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	-	-	R
	Coloburiscus	7	-	C	-	R
	Deleatidium	8	XA	XA	A	C
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	R	-	-
	Megaleptoperla	9	R	R	-	-
	Zelandoperla	8	VA	C	R	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	C	C
	Hydraenidae	8	R	-	-	R
	Staphylinidae	5	-	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	A	C	A
	Costachorema	7	C	A	-	R
	Hydrobiosis	5	C	R	R	-
	Hydrobiosella	9	R	-	-	-
	Neurochorema	6	-	R	-	-
	Plectrocnemia	8	R	-	-	-
	Psilochorema	6	C	R	-	-
	Olinga	9	R	R	-	-
	Oxyethira	2	-	-	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A	R	C
	Limonia	6	-	-	-	R
	Maoridiamesa	3	R	A	R	A
	Orthocladiinae	2	R	A	A	VA
	Tanytarsini	3	-	-	-	R
	Ephydridae	4	-	-	R	R
	Austrosimulium	3	-	C	A	-
	Tanyderidae	4	-	-	-	R
		No of taxa	15	17	13	21
		MCI	136	122	94	92
		SQMCIs	7.7	7.1	4.5	2.9
		EPT (taxa)	10	11	4	5
		%EPT (taxa)	67	65	31	24
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa				

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 165 Macroinvertebrate fauna of the Whenuakura River: for the spring SEM survey sampled on 14 December 2016 and summer SEM survey sampled on 20 March 2017

Taxa List	Site Code	MCI	WNR000450	WNR000450
	Sample Number	score	FWB16290	FWB17195
ANNELIDA (WORMS)	Oligochaeta	1	C	C
	Lumbricidae	5	-	R
MOLLUSCA	*Latia*	5	R	R
	Potamopyrgus	4	VA	VA
CRUSTACEA	*Paracalliope*	5	C	-
	Phreatogammarus	5	-	VA
	Talitridae	5	-	R
	Paratya	3	R	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	C
	Coloburiscus	7	-	R
	Mauiulus	5	-	C
	Rallidens	9	R	R
	Zephlebia group	7	-	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C	R
COLEOPTERA (BEETLES)	Elmidae	6	A	A
	Hydrophilidae	5	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	A
	Hydrobiosis	5	R	C
	Oecetis	4	C	-
	Oxyethira	2	R	C
	Pycnocentria	7	-	R
	Triplectides	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	R
	Orthocladiinae	2	A	C
	Tanypodinae	5	-	R
	Tanytarsini	3	A	A
	Empididae	3	-	R
	Muscidae	3	R	R
	Austrosimulium	3	R	R
	Tanyderidae	4	-	R
		No of taxa	18	29
		MCI	84	94
		SQMCIs	5.0	4.4
		EPT (taxa)	6	10
		%EPT (taxa)	33	34
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Appendix II

Summary of SEM sites' information 2016-2017 and historical MCI scores, predicted scores and 1995-2017 trends

Summary of MCI scores at all SEM sites: significance in relation to various predictive methodologies (Stark and Fowles, 2009; Leathwick, 2008), and trends over the SEM period 1995 to 2017

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI Values						Median 'health' category	Predictive MCI values			Time Trends (1995-2017)			
				Spring 2016	Summer 2017	Range	Medians to date: Spring	Summer	Overall		Distance[1]	Median of similar streams	REC[2]	P value	FDR p value	+ / -	Trendline MCI range
STY000300	CX/H/VA/S/MO/MG	160	7.3	-	107	64-160	113	111	113	Good	109[0]	108[0]	128[-]	0.06	0.10	-ve	16
STY000400	CX/H/VA/S/MO/MG	70	12.5	-	100	0-160	108	109	109	Good	103[0]	98[0]	115[0]	0.78	0.84	-ve	16
HRK000085	WW/L/VA/U/MO/MG	5	N/A	-	97	68-100	89	88	89	Fair	N/A	79[0]	89[0]	<0.01	0.01	+ve	12
HTK000350	WX/L/VA/P/MO/LG	60	N/A	-	110	79-115	101	95	96	Fair	N/A	95[0]	95[0]	<0.01	<0.01	+ve	15
HTK000425	WW/L/VA/P/MO/LG	30	N/A	-	109	91-115	106	103	104	Good	N/A	102[0]	92[+]	<0.01	<0.01	+ve	10
HTK000745	WW/L/VA/U/MO/MG	5	N/A	-	97	62-101	86	86	86	Fair	N/A	84[0]	93[0]	0.93	0.94	-ve	13
KPA000250	CX/H/VA/P/MO/MG	240	5.7	125	115	83-131	121	114	117	Good	112[0]	101[-]	111[0]	<0.01	<0.01	+ve	30
KPA000700	CX/H/VA/P/MO/MG	140	13.5	107	100	78-118	97	94	96	Fair	103[0]	102[0]	105[0]	<0.01	<0.01	+ve	28
KPA000950	CX/L/VA/P/MO/LG	20	25.2	88	93	76-101	89	81	87	Fair	96[0]	90[0]	99[-]	0.04	0.06	+ve	13
KTK000150	CW/L/VA/P/HO/LG	420	0	-	135	112-148	137	135	135	Very good	132[0]	134[0]	131[0]	0.02	0.03	-ve	15
KTK000248	WX/L/VA/P/MO/LG	5	18.1	-	102	87-118	102	102	102	Good	99[0]	90[-]	96[0]	0.70	0.82	+ve	18
KPK000250	CX/H/VA/IF/MO/MG	380	3.3	129	136	124-138	130	128	130	Very good	118[+]	129[0]	137[0]	0.16	0.24	+ve	37
KPK000500	CX/H/VA/P/MO/MG	260	9.2	105	113	98-133	121	112	116	Good	107[0]	113[0]	127[-]	<0.01	0.01	+ve	20
KPK000660	CX/H/VA/P/MO/LG	170	15.5	109	103	71-128	107	102	103	Good	101[0]	108[0]	122[-]	<0.01	<0.01	+ve	33
KPK000880	CW/H/VA/P/MO/LG	60	25.7	99	102	66-110	94	88	91	Fair	95[0]	98[0]	106[-]	<0.01	0.01	+ve	15
KPK000990	CW/L/VA/P/HO/LG	5	31.1	90	97	69-103	94	88	91	Fair	93[0]	90[0]	96[0]	<0.01	0.02	+ve	14
KRP000300	WX/L/VA/P/LO/LG	180	N/A	-	98	80-106	94	96	94	Fair	N/A	89[0]	92[0]	<0.01	<0.01	+ve	20
KRP000660	WW/L/VA/P/LO/LG	120	N/A	-	96	70-112	96	91	94	Fair	N/A	102[0]	102[0]	<0.01	<0.01	+ve	17
MKW000200	CX/H/VA/IF/MO/MG	380	2.3	-	142^	100-142	131	125	129	Very good	121[0]	129[0]	130[0]	0.94	0.94	+ve	12
MKW000300	CX/H/VA/P/MO/LG	150	15.5	-	112	90-119	109	105	107	Good	101[0]	102[0]	111[0]	<0.01	<0.01	+ve	17
MGH000950	CW/L/SS/P/HO/LG	120	N/A	92	92	77-104	94	91	92	Fair	N/A	93[0]	117[-]	<0.01	<0.01	+ve	19
MGN000195	CX/H/VA/P/MO/LG	330	8.7	124	106	113-143	130	123	126	Very good	107[+]	119[0]	124[0]	0.23	0.32	-ve	9
MGN000427	CX/L/VA/P/HO/MG	140	37.9	96	96	77-115	102	96	98	Fair	91[0]	103[0]	103[0]	0.36	0.47	+ve	7
MRK000420	WW/L/VA/P/MO/LG	60	N/A	-	96	75-105	93	89	90	Fair	N/A	79[+]	92[0]	<0.01	<0.01	+ve	16
MGT000488	WN/L/VA/P/LO/LG	30	N/A	-	73	56-91	78	79	78	Poor	N/A	68[0]	80[0]	0.44	0.54	+ve	9

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI Values						Median 'health' category	Predictive MCI values			Time Trends (1995-2017)			
				Spring 2016	Summer 2017	Range	Medians to date: Spring	Medians to date: Summer	Medians to date: Overall		Distance[1]	Median of similar streams	REC[2]	P value	FDR p value	+ / -	Trendline MCI range
MGT000520	WW/L/VA/U/LO/LG	20	N/A	-	72	44-79	65	67	66	Poor	N/A	79[-]	88[-]	<0.01	<0.01	+ve	24
MWH000380	WW/L/M/P/MO/LG	200	N/A	75	73	58-85	75	74	75	Poor	N/A	79[0]	92[-]	<0.01	<0.01	+ve	6
MWH000490	CN/L/VA/P/MO/LG	190	N/A	90	80	63-102	82	79	79	Poor	N/A	81[0]	93[-]	<0.01	<0.01	+ve	17
MGE000970	CX/L/VA/P/MO/LG	90	15.6	-	101	86-113	105	99	102	Good	101(0)	102[0]	101[0]	0.15	0.23	-ve	11
PAT000200	CX/H/VA/IF/MO/MG	500	1.9	140	150^	127-150	138	138	138	Very good	125[+]	134[0]	129[0]	0.21	0.30	+ve	8
PAT000315	CX/H/VA/P/MO/LG	300	12.4	116	120	99-130	116	109	111	Good	103[0]	119[0]	112[0]	0.04	0.08	+ve	6
PAT000360	CW/L/VA/P/HO/LG	240	19.2	96	96	86-105	99	96	98	Fair	99[0]	101[0]	109[-]	0.43	0.55	+ve	3
PNH000200	CX/H/YA/IF/MO/MG	270	4.4	123	127	104-137	127	121	124	Very good	115[0]	113[0]	121[0]	<0.01	<0.01	+ve	15
PNH000900	CW/L/VA/P/MO/LG	20	20.9	96	87	70-114	94	85	89	Fair	98[0]	90[0]	100[-]	<0.01	<0.01	+ve	20
TNH000090	WW/L/SS/P/MO/LG	85	N/A	98	106	90-107	97	103	100	Good	N/A	93[0]	110[-]	0.13	0.21	+ve	8
TNH000200	WW/L/SS/P/HO/LG	65	N/A	100	110^	92-110	103	104	103	Good	N/A	102[0]	108[0]	0.79	0.84	-ve	7
TNH000515	WW/L/SS/P/HO/LG	15	N/A	95	89	84-104	96	88	95	Fair	N/A	78[+]	95[0]	0.76	0.83	+ve	10
TMR000150	CX/H/VA/IF/LO/HG	420	0	-	152^	119-152	136	138	138	Very good	132[0]	134[0]	141[0]	0.15	0.23	+ve	9
TMR000375	CX/L/VA/P/MO/MG	100	10.9	-	110	89-120	106	102	103	Good	105[0]	102[0]	117[-]	<0.01	<0.01	+ve	18
WAI000110	WW/L/VA/P/MO/LG	50	N/A	-	94	80-101	92	88	91	Fair	N/A	79[+]	91[0]	<0.01	<0.01	+ve	11
WMK000100	WW/L/VA/P/LO/HG	160	0	-	137	121-141	132	130	131	Very good	132[0]	108[-]	128[0]	0.60	0.73	+ve	5
WMK000298	WW/L/VA/P/MO/MG	1	4	-	94	75-105	94	89	92	Fair	116[-]	90[0]	103[-]	<0.01	<0.01	+ve	12
WGG000115	CX/H/VA/IF/LO/MG	540	0.7	129	133	122-144	132	134	132	Very good	132[0]	134[0]	131[0]	0.17	0.24	+ve	8
WGG000150	CX/H/VA/P/LO/MG	380	7.2	121	124	119-139	132	126	129	Very good	110[+]	129[0]	124[0]	0.62	0.73	+ve	9
WGG000500	CW/L/VA/P/MO/LG	200	23	101	104	91-124	103	102	102	Good	97[0]	101[0]	110[0]	<0.01	<0.01	+ve	10
WGG000665	CW/L/VA/P/HO/MG	180	29.6	104	101	77-111	98	93	96	Fair	94[0]	108[-]	102[0]	<0.01	<0.01	+ve	12
WGG000895	CW/L/VA/P/HO/LG	40	63	97	88	73-106	97	94	95	Fair	85[0]	93[0]	92[0]	0.28	0.37	+ve	5
WGG000995	CW/L/VA/P/HO/MG	5	66.6	90	83	69-100	93	86	91	Fair	85[0]	90[0]	95[0]	0.02	0.04	+ve	11
WKR000500	WW/L/VA/P/MO/LG	150	N/A	111	97	88-114	102	98	99	Fair	N/A	102[0]	97[0]	<0.01	<0.01	+ve	10
WKR000700	WW/L/VA/P/MO/LG	70	N/A	98	94	92-109	98	98	98	Fair	N/A	98[0]	95[0]	0.84	0.87	-ve	5
WGA000260	CX/L/VA/P/MO/LG	140	16.1	-	100	82-112	99	95	97	Fair	100[0]	102[0]	99[0]	0.02	0.04	+ve	9
WGA000450	WW/L/VA/P/MO/LG	20	31.2	-	88	72-102	93	87	90	Fair	93[0]	90[0]	88[0]	<0.01	<0.01	+ve	18

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI Values						Median 'health' category	Predictive MCI values			Time Trends (1995-2017)			
				Spring 2016	Summer 2017	Range	Medians to date				Distance[1]	Median of similar streams	REC[2]	P value	FDR p value	+ / -	Trendline MCI range
							Spring	Summer	Overall								
WTR000540	WX/L/SS/P/HO/LG	100	N/A	95*	102^	95-102	97	100	99	Fair	N/A	93[0]	110[-]	N/T	N/T	-	-
WTR000850	WX/L/SS/P/HO/LG	15	N/A	96	85	64-107	91	81	86	Fair	N/A	78[0]	98[-]	<0.01	0.02	+ve	17
WKH000100	CX/H/VA/IF/LO/HG	460	0	-	136	115-147	131	126	130	Very good	132[0]	134[0]	137[0]	0.29	0.38	+ve	6
WKH000500	CX/H/VA/P/MO/MG	175	10.6	-	122	87-125	112	109	111	Good	105[0]	108[0]	115[0]	<0.01	<0.01	+ve	16
WKH000920	CX/H/VA/P/HO/LG	20	26.6	-	94	71-110	99	92	94	Fair	95[0]	90[0]	97[0]	0.63	0.72	+ve	11
WKH000950	CX/H/VA/P/HO/LG	2	28.4	-	92	70-111	92	83	89	Fair	94[0]	90[0]	97[0]	0.52	0.63	+ve	8
WNR000450	WW/L/SS/P/HO/LG	20	N/A	84	94^	81-94	87	88	87	Fair	N/A	78[0]	109[-]	N/T	N/T	-	-

Notes: ( ) = affected by headwater erosion events; Trend highly significant ($p<0.01$), significant ($p<0.05$) and not significant ($p\geq0.05$); [+ve/-ve/-] = wheter a trend line was positive, negative or absent; N/A = non-ringplain source inside NP sites; N/A[s] = soft-bedded sites;^ = highest recorded MCI score for that site; * = lowest recorded MCI score for that site, 1 = Stark and Fowles, 2009' 2 = Leathwick, 2009; N/T = not trended (insufficient data at present).