Fresh Water Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2009-2010

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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.

This report covers the 2009-2010 monitoring year. Biological surveys were performed in spring (November 2009 through to late December 2009: partly delayed by a wet early to mid-spring period) and summer (February to mid March 2010), the latter during a late summer low flow period. Each survey assessed the macroinvertebrate communities at 57 sites in 25 rivers and streams. The Hangatahua (Stony) River was selected as a river with high conservation value and the Maketawa Stream was identified in the Regional Freshwater Plan 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. The Waingongoro River was included in the programme as a river under intensive usage and the Waiongana Stream as a stream from which there is a major water abstraction. 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, which have been part of the monitoring programme for the ninth time this year. 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 recent community walkway planting initiatives.

The spring 2009 surveys were performed either side of a period of early and mid spring freshes and with a few delayed into early summer The summer surveys were performed during and after a period of late summer recession, low flow conditions. For sites located lower in catchments the proportion of 'sensitive' taxa in the macroinvertebrate communities was generally lower in summer than in spring but not to the same extend as in the past years. This was coincident with lower flows and some increase in smothering of habitats by more widespread algal growth within rivers and streams in summer. The surveys indicated that generally the proportion of 'sensitive' taxa in the macroinvertebrate communities declined down the length of the waterways which was reflected in the deterioration in generic stream 'health' from 'very good' in the upper reaches though 'good' in mid-reaches to ‘fair’ to ‘good’ in the lower reaches. Some sites exhibited the typical summer trend of decreased scores, more particularly at mid and lower reach sites, but again not to the same extend as recorded in past years.

The macroinvertebrate communities at all ringplain sites have also been assessed in terms of predictive relationships recently established for ringplain streams taking into account altitude and/or distance from the National Park. Evaluations of generic and predictive stream ‘health’ have also been performed and assessments made for all sites in relation to River Environment Classification (REC) preditions.

The trends through time have been evaluated and will continue to be assessed on an annual basis as the SEM programme continues. No statistically significant temporal deterioration in MCI scores has been found at any site, whereas seven sites have shown very strong improvements and a further eleven sites, strong improvement, most of which were of ecological significance.

Substrate instability and sedimentation caused by extensive headwater erosion events in recent years have continued to affect the macroinvertebrate communities at upper sites in the Stony River (in particular), Maketawa Stream, Waiwhakaiho River, Katikara Stream and Timaru Stream most of which showed marked recovery over the 2009 – 2010 period

The recommendations for the 2010-2011 monitoring year provide for the freshwater biological component of the SEM monitoring to be maintained by way of a similar macroinvertebrate faunal programme and for temporal trend reporting 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 monitoring activity results for the year and provide a brief interpretation of these results.

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. In future, Annual SEM reports will consider trends in stream health for additional sites as the data record for each monitoring activity increases with time.

This report summarises the results for the sites surveyed in the freshwater biological SEM programme over the 2009-2010 monitoring year, the fifteenth year of this programme.

2. Monitoring activity

2.1 Introduction

The Council commenced the freshwater biological SEM programme in spring 1995. The 2009-2010 monitoring year was therefore the fifteenth year in which this SEM programme was undertaken. This report presents the results from the sites surveyed in the 2009-2010 monitoring year. The methodology for the programme is described in TRC (1997b) and summarised below.

2.2 Monitoring methodology

The standard '400 ml kick-sampling' technique was 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). This 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001). Surveys of all sites were performed twice during the monitoring year, once during spring (October to December) and once during summer (February and March). Sampling dates 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 found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

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.

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.

Ringplain rivers and streams sites' data have also been compared with relevant historical survey data which have been used to establish relationships between MCI scores and altitude and distance from stream/river source (National Park boundary) on the ringplain (Stark and Fowles, 2009). These generic relationships for predicting MCI in ringplain streams/rivers are:

$MCI = 84.43 + 0.102A$ [where A= altitude (masl)]; and
$MCI = 131.72 – 25.83 \log_{10} D$ [where D = distance from source (km)]

and have been based upon more than 2400 TRC surveys of about 300 ringplain 'control' sites over the period from 1980 to 2008.

Rates of MCI change have been calculated for each river or stream, where more than a single site has been surveyed, based upon updated G.I.S. river/stream length information incorporated into the Council's 'SITES' database system. [Note: these MCI rates (units/km) of downstream change may differ from earlier reported calculations due to more recent refinements to the accurate determination of river length measurements].

2.3.3 Gradations of biological 'health'

An adaption 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 ranges. This gradation is presented in Table 1.

Table 1 Generic MCI gradation of biological water quality conditions adapted for Taranaki streams and rivers

Grading	MCI	Code	Stark's classification
Excellent	>140		Excellent
Very Good	120-140		
Good	100-119		Good
Fair	80-99		Fair
Poor	60-79		Poor
Very Poor	<60		

This generic adaption is considered to provide a more useful reflection of stream 'health' in the context of more precise MCI score bands. 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.

Following the establishment of relationships between MCI scores and ringplain stream altitude and distance from source (Stark and Fowles, 2009), the biological 'health' MCI score gradations presented in Table 1 have been extrapolated for the upper, middle and lower reaches of ringplain streams (as presented in Table 2). This modified gradation of biological 'health' appears to provide a more appropriate assessment according to site location, recognising a degree of 'natural' degradation in stream biological habitat in a downstream direction between the National Park and the coast (on average, over a distance of 25 to 30 km).

Table 2 MCI gradation of biological 'health' categories adapted for upper, middle, and lower reaches of Taranaki ringplain streams/rivers (based on the relationships for ringplain streams of Stark and Fowles, 2009)

Grading	MCI scores for reaches		
	Upper	Middle	Lower
Well above expected	>145	>120	>105
Better than expected	135-145	101 – 120	90 – 105
Expected	130-134	88 – 100	76 – 89
Worse than expected	120-129	73 – 87	60 – 75
Well below expected	<120	<55 – 72	<50 - 59
Distance from NPk (km)	0 – 2.5	2.6 – 20	>20
Altitude (masl)	>350	100 - 350	<100

Both systems of grading sites' biological 'health' have been utilised for presentation (see Appendix II) and discussion of data in this report.

2.3.4 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. 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.

2.4 Trend analysis

State of the environment (SEM) macroinvertebrate data, collected at the 51 SEM sites in the region over the fifteen year period (1995-2010) under standard TRC programme protocols, have been statistically analysed for trends using documented methodology (Stark and Fowles, 2006). The significance of any (positive or negative) trends found has been provided for the principal index of stream 'health', the MCI, which was selected as the most appropriate index for use in the assessment of temporal trends in the macroinvertebrate biological quality of regional surface freshwaters (see Stark and Maxted, 2007).

The significance of any site's trend (i.e. the strength of the trend) can be ranked (eg from strongest to weakest) according to the statistical probability of occurrence (p-value), as long as similar numbers of samples were collected for analysis (G McBride, NIWA pers comm) which has been the case with the TRC programme.

Following LOWESS [Locally Weighted Scatterplot] smoothing of the temporal MCI data for each site (Stark and Fowles, 2006), the statistical significance of all sites' trends can be ordered (from strongest to weakest) for all sites, with a short-list of sites provided in terms of the strengths of significant trends. The 'cut-off' point has been chosen as those sites' trends with probabilities significant at the 5% level (followed by false discovery rate (FDR) analysis). Those sites can be ranked in order beginning at the lowest p-value. This approach is statistically defensible and should identify sites having trends with valid ecological significance. However, a trend may be statistically significant but have no ecological significance or vice versa. The consideration of ecological significance requires the best professional judgment (BPJ) of a freshwater ecologist with knowledge of the region's rivers and streams. It is likely that the strongest trends (lowest p-values) would have the greatest ecological significance.

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 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 modified (using BPJ) as illustrated in Section 2.3.2 above.

2.5 Assessment of significant differences

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). Between season and long term median MCI scores and/or taxa richnesses may also be compared using t-tests (Stark and Maxted, 2007).

2.6 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 2009-2010 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 has continued to be affected by headwater erosion in recent years. Therefore, the programme was reviewed in 2006 and the Waiaua River excluded from the SEM trending 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.

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

Type		River/stream	Site	Site code	GPS location		Distance from Nat Park (km)	Altitude (m asl)	Spring sampling date	Summer sampling date
					E	N				
Conservation		Hangatahua (Stony) R	Mangatete Road	STY000300	1677460	5657823	7.3	160	16 Nov 09	8 Feb 10
		Hangatahua (Stony) R	SH45	STY000400	1674632	5661558	12.5	70	16 Nov 09	8 Feb 10
		Maketawa S	Opp Denby Road	MKW000200	1702192	5656304	2.3	380	13 Nov 09	9 Feb 10
		Maketawa S	Tarata Road	MKW000300	1708784	5665231	15.5	150	13 Nov 09	9 Feb 10
Large catchment/ multiple impacts		Waiwhakaiho R	National Park	WKH000100	1696096	5658351	0	460	17 Nov 09	10 Mar 10
		Waiwhakaiho R	SH3 (Egmont Village)	WKH000500	1698297	5666893	10.6	175	17 Nov 09	10 Mar 10
		Waiwhakaiho R	Constance St (NP)	WKH000920	1695827	2677271	26.6	20	17 Nov 09	10 Mar 10
		Waiwhakaiho R	Adjacent to L Rotomanu	WKH000950	1696587	2678336	28.4	2	17 Nov 09	10 Mar 10
		Mangorei S	SH3	MGE000970	1696094	5671500	21.6	90	17 Nov 09	10 Mar 10
		Manganui R	SH3	MGN000195	1708871	5651282	8.7	330	13 Nov 09	9 Feb 10
		Manganui R	Bristol Road	MGN000427	1711210	5667887	37.9	140	13 Nov 09	9 Feb 10
		Waitara R	Mamaku Road	WTR000850	1708384	5678739	N/A	15	13 Nov 09	11 Mar 10
		Patea R	Barclay Rd	PAT000200	1702620	5646598	1.9	500	6 Nov 09	2 Feb 10
		Patea R	Swansea Rd	PAT000315	17118011	5644382	12.9	300	6 Nov 09	2 Feb 10
		Patea R	Skinner Rd	PAT000360	715919	5644681	19.2	240	6 Nov 09	2 Feb 10
Intensive usage		Waingongoro R	700m d/s Nat Park	WGG000115	1700835	5645086	0.7	540	30 Nov 09	8 Feb 10
		Waingongoro R	Opunake Rd	WGG000150	1705692	5642523	7.2	380	30 Nov 09	8 Feb 10
		Waingongoro R	Eltham Rd	WGG000500	1710576	5634824	23.0	200	30 Nov 09	8 Feb 10
		Waingongoro R	Stuart Rd	WGG000665	1709784	5632049	29.6	180	30 Nov 09	8 Feb 10
		Waingongoro R	SH45	WGG000895	1704042	5618667	63.0	40	30 Nov 09	8 Feb 10
		Waingongoro R	Ohawe Beach	WGG000995	1702531	5617624	66.6	10	30 Nov 09	8 Feb 10
Primary agricultural		Timaru S	Carrington Road	TMR000150	1684423	5659634	0	420	16 Nov 09	8 Feb 10
		Timaru S	SH45	TMR000375	1679509	5665554	10.9	100	16 Nov 09	8 Feb 10
		Mangaoraka S	Corbett Road	MRK000420	1702538	5676320	N/A	60	10 Nov 09	1 Feb 10
		Punehu S	Wiremu Rd	PNH000200	1687323	5637020	4.4	270	12 Nov 09	4 Feb 10
		Punehu S	SH45	PNH000900	1677946	5627786	20.9	20	12 Nov 09	4 Feb 10
		Waiokura S	Skeet Rd	WKR000500	1698807	5628892	N/A	150	12 Nov 09	5 Feb 10
		Waiokura S	Manaia Golf Course	WKR000700	1697636	5622019	N/A	70	12 Nov 09	5 Feb 10
Eastern hill country		Tangahoe R	Upper Valley	TNH000090	1725340	5626101	N/A	85	9 Nov 09	15 Feb 10
		Tangahoe R	Tangahoe Vly Rd bridge	TNH000200	1719126	5622681	N/A	65	9 Nov 09	15 Feb 10
		Tangahoe R	d/s railbridge	TNH000515	1715751	5612470	N/A	15	9 Nov 09	15 Feb 10
		Mangaehu R	Raupuha Rd	MGH000950	1726300	5639062	N/A	120	6 Nov 09	2 Feb 10
Riparian	Western	Waimoku S	Lucy's Gully	WMK000100	1681324	5666240	0	160	16 Nov 09	8 Feb 10
		Waimoku S	Beach	WMK000298	1681725	5669851	4.0	1	16 Nov 09	8 Feb 10
		Katikara S	Carrington Road	KTK000150	1683566	5657855	0	420	12 Nov 09	3 Feb 10
		Katikara S	Beach	KTK000248	1676597	5667473	18.1	5	16 Nov 09	3 Feb 10
		Kapoaiaia S	Wiremu Road	KPA000250	1678009	5652025	5.7	240	4 Nov 09	4 Feb 10
		Kapoaiaia S	Wataroa Road	KPA000700	1672739	5652272	13.5	140	4 Nov 09	4 Feb 10
		Kapoaiaia S	Cape Egmont	KPA000950	1665690	5652452	25.2	20	4 Nov 09	4 Feb 10
	Southern	Kaupokonui R	Opunake Road	KPK000250	1698088	5639231	3.3	380	12 Nov 09	5 Feb 10
		Kaupokonui R	U/s Kaponga oxi ponds	KPK000500	1698609	5634423	9.2	260	12 Nov 09	5 Feb 10
		Kaupokonui R	U/s Lactose Co.	KPK000660	1697613	5629791	15.5	170	12 Nov 09	5 Feb 10
		Kaupokonui R	Upper Glenn Road	KPK000880	1693026	5622705	25.7	60	12 Nov 09	5 Feb 10
		Kaupokonui R	Near mouth	KPK000990	1691209	5620444	31.1	5	12 Nov 09	5 Feb 10
Small degraded ('poor') catchment		Mangati S	D/s railway line	MGT000488	1700095	5678043	N/A	30	22 Dec 09	11 Mar 10
		Mangati S	Te Rima Pl, Bell Block	MGT000520	1699385	5679103	N/A	20	22 Dec 09	11 Mar 10
		Mangawhero S	u/s Eltham WWT Plant	MWH000380	1712475	5633431	N/A	200	30 Nov 09	8 Feb 10
		Mangawhero S	d/s Mangawharawhara S	MWH000490	1710795	5632738	N/A	190	30 Nov 09	8 Feb 10
		Kurapete S	u/s Inglewood WWT Plant	KRP000300	1705087	5665510	N/A	180	10 Nov 09	1 Feb 10
		Kurapete S	6 km d/s Inglewood WWTP	KRP000660	1709239	5667481	N/A	120	10 Nov 09	1 Feb 10
Urbanisation		Huatoki S	Hadley Drive	HTK000350	1693349	5671486	N/A	60	17 Nov 09	12 Mar 10
		Huatoki S	Huatoki Domain	HTK000425	1693041	5673404	N/A	30	17 Nov 09	12 Mar 10
		Huatoki S	Molesworth St	HTK000745	1692800	5676424	N/A	5	17 Nov 09	12 Mar 10
		Herekawe S	Centennial Drive	HRK000085	1688283	5674972	N/A	5	22 Dec 09	12 Mar 10
Northern lowland catchment		Waiau S	Inland North Road	WAI000110	1714587	5680018	N/A	50	10 Nov 09	1 Feb 10
Major abstraction		Waiongana S	SH3a	WGA000260	1705159	5669554	16.1	140	13 Nov 09	11 Mar 10
		Waiongana S	Devon Road	WGA000450	1704063	5680381	31.2	20	13 Nov 09	11 Mar 10

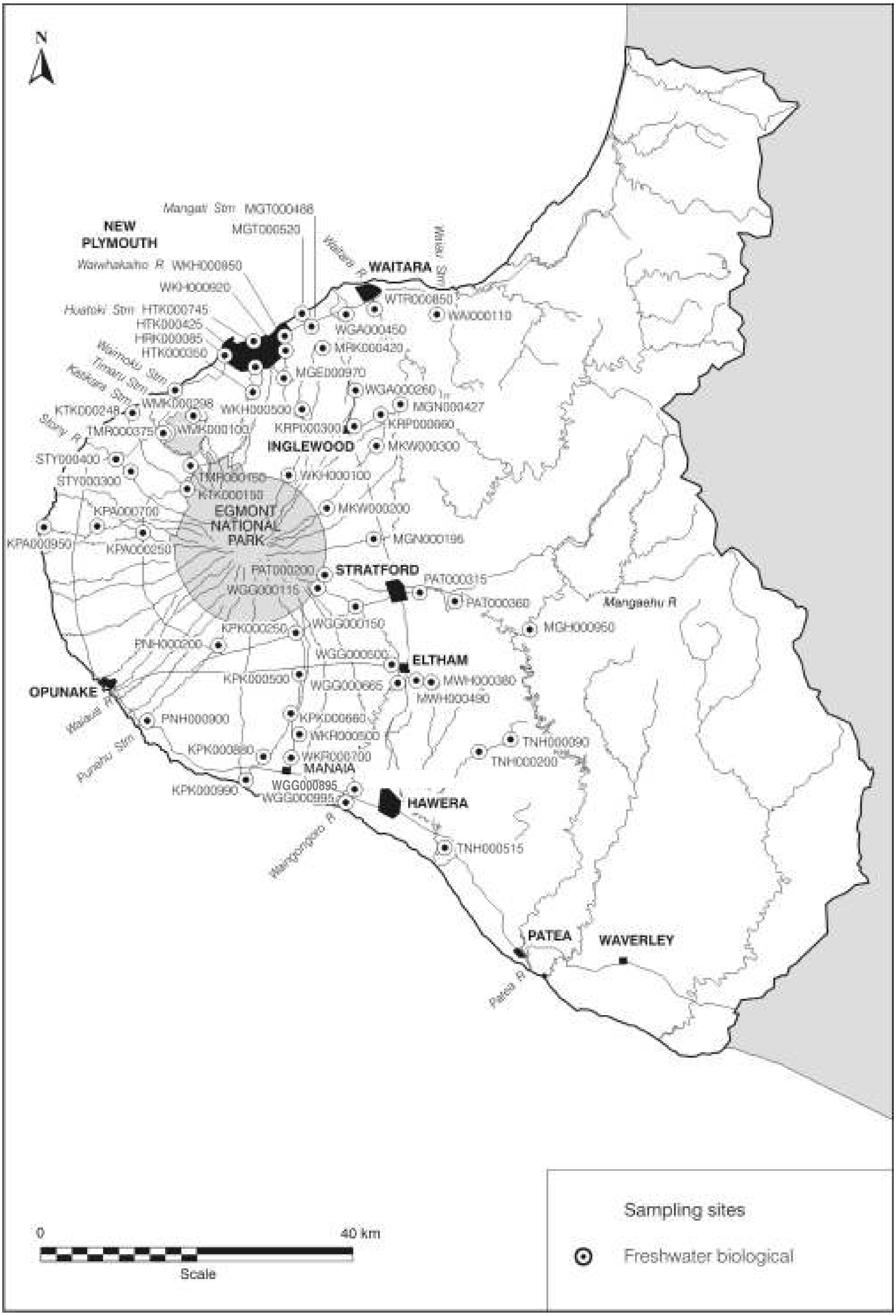


Figure 1 Location of macroinvertebrate fauna sampling sites for the 2009-2010 SEM programme

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 (aforestation) 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, exceptions occur 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.

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 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 synchronise 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.

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 Mamaku Road site is located six kilometres upstream of the coast above any tidal influence. This site is 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 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, near 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. 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 2 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 special order consent 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 receives 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 Eltham point source discharges. The Stuart Road site, a further six km downstream is located below these discharges, with a further two sites (SH45 and Ohawe Beach) 33 km and 37 km downstream of Stuart Road and located 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 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 is currently being upgraded, 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 1997-98 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 Pukeariki 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.

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. Recent 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 current riparian vegetation is poor. 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 but 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 NIWA telemetry recorder is located at Cape Egmont.

3. Results and discussion

3.1 Flows and water temperature

Hydrological flow recorders continuously monitor water levels in the Mangaoraka, Waiongana, Punehu, and Kapoaiaia Streams, and the Waiwhakaiho, Manganui, Stony, Patea, Mangaehu, Waingongoro, Kaupokonui and Waitara Rivers. Flow conditions can therefore be determined in these watercourses for the period prior to the collection of biological samples. The proximity of previous freshes for each site surveyed, are summarised in Table 4, with flow assessments extrapolated from nearby catchments for sites where flow recorders were not available.

Table 4 Duration since freshes at sampling sites in the 2009-2010 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	13	25	16	16
Hangatahua (Stony) R	SH45	13	25	16	16
Timaru S	Carrington Road	(13)	(25)	(16)	(16)
Timaru S	SH45	(13)	(25)	(16)	(16)
Mangaoraka S	Corbett Road	14	14	21	51
Waiongana S	SH3a	17	17	14	14
Waiongana S	Devon Road	17	17	14	14
Waiwhakaiho R	National Park	21	21	15	15
Waiwhakaiho R	SH3 (Egmont Village)	21	21	15	15
Waiwhakaiho R	Constance St (NP)	21	21	15	15
Waiwhakaiho R	Adjacent Lake Rotomanu	21	21	15	15
Mangorei S	SH3	(21)	(21)	(15)	(15)
Manganui R	SH3	17	27	14	19
Manganui R	Bristol Road	17	27	14	19
Maketawa S	opp Denby Road	(17)	(27)	(14)	(19)
Maketawa S	Tarata Road	(17)	(27)	(14)	(19)
Waitara R	Mamaku Road	16	26	13	14
Mangati S	D/s railway line	(8)	(10)	(14)	(14)
Mangati S	Te Rima Pl, Bell Block	(8)	(10)	(14)	(14)
Waimoku S	Lucy's Gully	(13)	(25)	(16)	(16)
Waimoku S	Beach	(13)	(25)	(16)	(16)
Waiau S	Inland North Road	(14)	(14)	(21)	(51)
Punehu S	Wiremu Rd	14	21	12	12
Punehu S	SH45	14	21	12	12
Patea R	Barclay Rd	8	10	52	76
Patea R	Swansea Rd	8	10	52	76
Patea R	Skinner Rd	8	10	52	76
Mangaehu R	Raupuha Road	9	19	51	52
Mangawhero S	u/s Eltham WWT Plant	(12)	(-)	(57)	(-)
Mangawhero S	d/s Mangawharawhara S	(12)	(-)	(57)	(-)
Waingongoro R	900m d/s Nat Park	12	12	13	82
Waingongoro R	Opunake Rd	12	12	13	82
Waingongoro R	Eltham Rd	12	12	13	82
Waingongoro R	Stuart Rd	12	12	13	82
Waingongoro R	SH45	12	12	13	82
Waingongoro R	Ohawe Beach	12	12	13	82
Huatoki S	Hadley Drive	(21)	(21)	(15)	(15)
Huatoki S	Huatoki Domain	(21)	(21)	(15)	(15)
Huatoki S	Molesworth St	(21)	(21)	(15)	(15)
Kaupokonui R	Opunake Rd	14	21	9	10
Kaupokonui R	U/s Kaponga oxi ponds	14	21	9	10
Kaupokonui R	U/s Lactose Co.	14	21	9	10
Kaupokonui R	Glenn Rd	14	21	9	10
Kaupokonui R	Beach	14	21	9	10
Katikara S	Carrington Road	(9)	(21)	(11)	(11)
Katikara S	Near mouth	(9)	(21)	(11)	(11)
Kapoaiaia S	Wiremu Road	8	18	12	12
Kapoaiaia S	Wataroa Road	8	18	12	12
Kapoaiaia S	Near coast	8	18	12	12
Kurapete S	u/s Inglewood WWTP	(14)	(14)	(21)	(51)
Kurapete S	6km d/s Inglewood WWTP	(14)	(14)	(21)	(51)
Tangahoe R	Upper Valley	(9)	(11)	(22)	(64)
Tangahoe R	Tangahoe Valley Road	(9)	(11)	(22)	(64)
Tangahoe R	d/s railbridge	(9)	(11)	(22)	(64)
Waiokura S	Skeet Road	(14)	(21)	(9)	(10)
Waiokura S	Manaia Golf-Course	(14)	(21)	(9)	(10)
Herekawe S	Centennial Drive	(8)	(10)	(15)	(15)
Herekawe S	Centennial Drive	(8)	(10)	(15)	(15)

NB: ( ) = extrapolation from nearby catchment

Spot water temperatures recorded at each site at the time of sampling during spring 2009 and summer 2010 SEM biomonitoring surveys are summarised in Table 5.

Table 5 Water temperature recorded at the times of SEM biological monitoring surveys

Watercourse	Spring 2009	Summer 2010
Hangatahua (Stony) River	12.1-13.1	18.0-19.8
Timaru Stream	9.5-14.0	15.8-21.6
Mangaoraka Stream	11.9	20.6
Waiongana Stream	13.6-15.4	16.1-18.5
Waiwhakaiho River	9.4-17.5	10.0-19.0
Mangorei Stream	15.4	15.7
Manganui River	10.1-14.5	15.7-21.4
Maketawa Stream	10.6-12.5	17.7-19.4
Waitara River	17.2	19.8
Mangati Stream	14.5-4.9	16.3-16.9
Waimoku Stream	11.1-14.6	15.0-19.2
Waiau Stream	12.1	20.2
Punehu Stream	10.9-12.4	15.8-19.1
Patea River	9.0-12.9	11.5-16.1
Mangaehu River	16.2	20.4
Mangawhero Stream	14.0-14.6	18.6-19.2
Waingongoro River	11.7-16.2	12.8-23.1
Huatoki Stream	13.0-16.1	14.7-15.6
Kaupokonui River	7.3-13.2	11.7-18.7
Katikara Stream	8.3-15.4	16.1-21.2
Kapoaiaia Stream	10.2-13.0	17.1-20.6
Kurapete Stream	10.8-11.6	15.9-17.7
Tangahoe River	13.8-15.1	17.6-18.6
Waiokura Stream	11.1-12.2	14.4-16.6
Herekawe Stream	13.7	16.1

(Note: N/R = not recorded)

3.1.1 Water temperature

Spring 2009

The spring 2009 surveys were delayed toward late spring after relatively short recessions of one to two weeks before freshes further delayed a few surveys until mid December. Spring surveys in nearly all streams were conducted from 8 to 14 days after moderate freshes while a few were up to 21 days after freshes. Water temperatures ranged from 7.3˚C to 11.7˚C in the upper reaches; 10.1˚C to 13.8˚C in middle reaches and from 10.9˚C to 17.5˚C in the lower reaches of streams and rivers at the time of the surveys (Table 5).

Summer 2010

Generally, rivers and streams were in low recession flow following a dry, late summer-autumn 2010 period. All surveys were performed during this period and followed 9 days to 8 weeks after significant freshes, the majority more than 15 days after a significant (3x median) fresh.

Water temperatures ranged from 10.0°C to 16.1°C in the upper reaches, 14.4°C to 18.0 °C in the mid reaches and from 15.6°C to 23.1°C in the lower reaches of streams and rivers at the time of the surveys (Table 5).

3.2 Macroinvertebrate communities

Lists of the taxa found during spring 2009 and summer 2010 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 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

Prior to the commencement of the SEM programme (in 1995), three samples had been collected from the site at State Highway 45. During the 1999-2000 monitoring year, an extra survey was performed in July 1999, and an extra site (STY000260, near the end of Saunders Road) was included in all three surveys, in order to closely monitor the recovery of the Stony River following massive sand drifts in the channel. This extra monitoring had not been conducted in subsequent monitoring years until 2004, following the very heavy rainfall events in late summer.

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 3 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. The results of spring (2009) and summer (2009-2010) surveys are presented in Table 126 and Table 127, Appendix I.

3.2.1.1 Mangatete Road site (STY000300)

3.2.1.1.1 Taxa richness and MCI

Thirty-one surveys have been undertaken in the Stony River at this mid-reach site between October 1995 and March 2009. 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 spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
STY000300	31	1 – 21	10	64 – 160	113	11	104	9	104

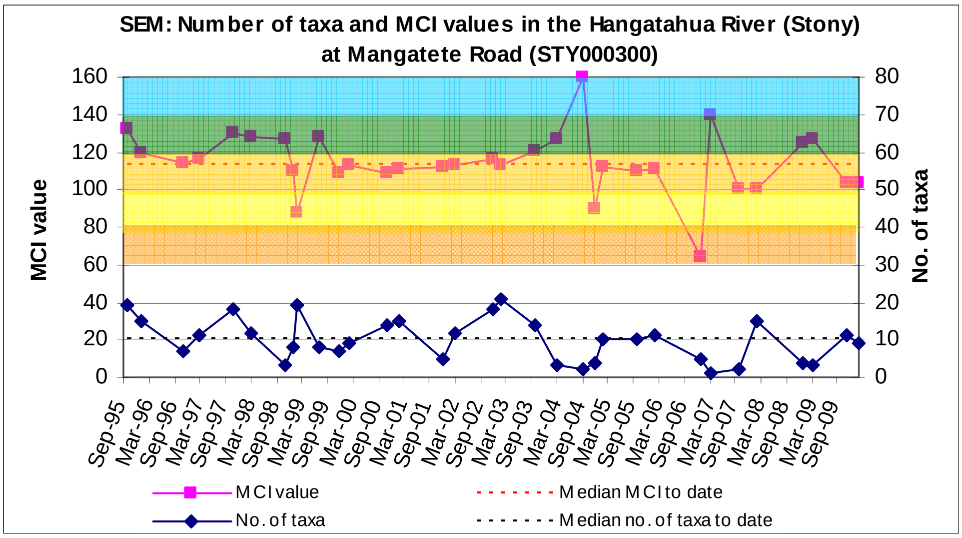


Figure 2 Numbers of taxa and MCI values in the Hangatahua (Stony) River at Mangatete Road

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 m asl). In the 2009-2010 period, richness was very similar to this median on both spring and summer sampling occasions, indicative of continuing erosion impacts of scouring, finer sediment deposition, and bed movement.

While it is recognised that there may be significant limitations to the appropriateness of the MCI when community compositions are 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 64 and 160 units with a median MCI value of 113 units. Both 2009-2010 scores (104 units) were identical and an insignificant 9 units below the historical median. Both spring and summer scores categorised this site as having 'good' health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health for the mid-reaches of a ringplain river at the times of the surveys. The historical median score (113 units) also placed this site's river health in these two categories.

3.2.1.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 7.

Table 7 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Stony River at Mangatete Road between 1995 and March 2009 [31 surveys] and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	1	3		
EPHEMEROPTERA	*Deleatidium*	8	21	68	VA	VA
PLECOPTERA	*Zelandoperla*	8	9	29		
COLEOPTERA	Elmidae	6	11	35		
TRICHOPTERA	*Aoteapsyche*	4	3	10		
	Costachorema	7	4	13		A
	Hydrobiosis	5	1	3		
	Oxyethira	2	1	3		
DIPTERA	*Aphrophila*	5	1	3		
	Eriopterini	5	4	13		
	Maoridiamesa	3	3	10		
	Orthocladiinae	2	5	16	A	A

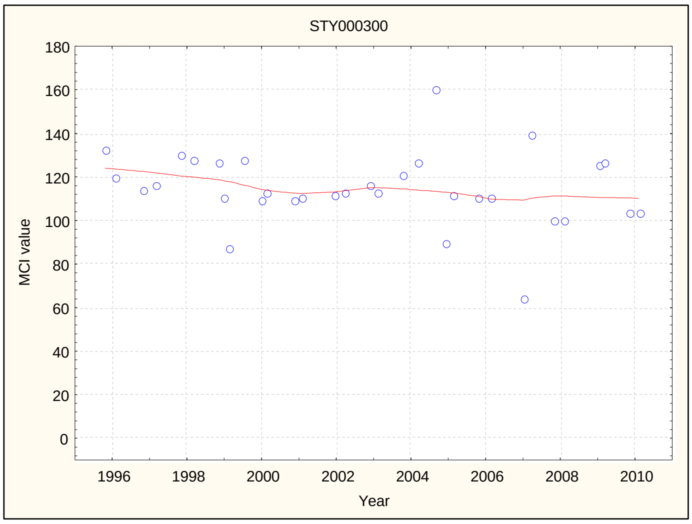
Prior to the current 2009-2010 period, twelve taxa have characterised this site's communities on occasions. These are comprised of two 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa. Predominant taxa have included two 'highly sensitive' taxa (the ubiquitous mayfly (*Deleatidium*) and stonefly (*Zelandoperla*)) and one 'moderately sensitive' taxon (elmid beetles). These taxa are often present (frequently in large numbers) on unstable shingle-cobble substrates (Death, 2000) and during recovery from erosion/siltation events (Fowles, 1987).Two of these taxa (*Deleatidium* and 'tolerant' orthoclad midges) were dominant in the spring community and three of these taxa (*Deleatidium*, orthoclad midges, and 'moderately sensitive' free-living (*Costachorema*)) were dominant in the summer community; both these results indicative of the reduction in diversity of characteristic taxa due to past headwater erosion impacts. The abundances of orthoclad midges on both occasions was coincident with the presence of thin periphyton mats on the cobble-boulder substrate; an indication of partial recovery (stability) since severe scouring/erosion events. The relative similarity in characteristic taxa on both occasions was reflected in the minimal difference in $SQMCI_s$ scores of 0.1 unit between seasons (Tables 126 and 127).

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 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 101 (altitude) and 109 (distance) for this site. The historical site median (113 units) is significantly higher (Stark, 1998) than the altitude prediction and 4 units above the distance predictive value while both the spring, 2009 and summer, 2010 surveys' scores were within 5 units of predictive values. Of the 33 surveys to date at this site, only 15% of MCI scores have been less than 101 units while 45% have been greater than 109 units.

3.2.1.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Stony River at Mangatete Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes (with the proviso noted earlier for this Stony River site). A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 3.



N = 33
Kendall tau = - 0.223
p level = 0.069 [>FDR, p = 0.170]
N/S at $p < 0.05$

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

Although a slight trend or decreasing MCI score is illustrated, this has not been statistically significant. This site has a LOWESS-smoothed range of MCI scores of about 14 units indicative of some significant ecological variability over the period, not surprising given the erosion effect documented earlier. Overall this smoothed trend line shows generic river 'health' (Table 1) deteriorating slightly from 'very good' to 'good' while, in terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain river, 'health' has also deteriorated slightly but from 'well above expected' to ' better than expected'. However, the majority of the variability has been caused by severe headwater erosion events at intervals over the period.

3.2.1.2 SH 45 site (STY000400)

3.2.1.2.1 Taxa richness and MCI

Thirty-one surveys have been undertaken in the Stony River at this lower reach site between October 1995 and March 2009. These results are summarised in Table 6, together with results from the current period, and illustrated in Figure 6.

Table 8 Results from SEM surveys performed in the Stony River at SH 45 prior to spring 2009 together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
STY000400	31	0-18	9	0-160	108	6	110	8	105

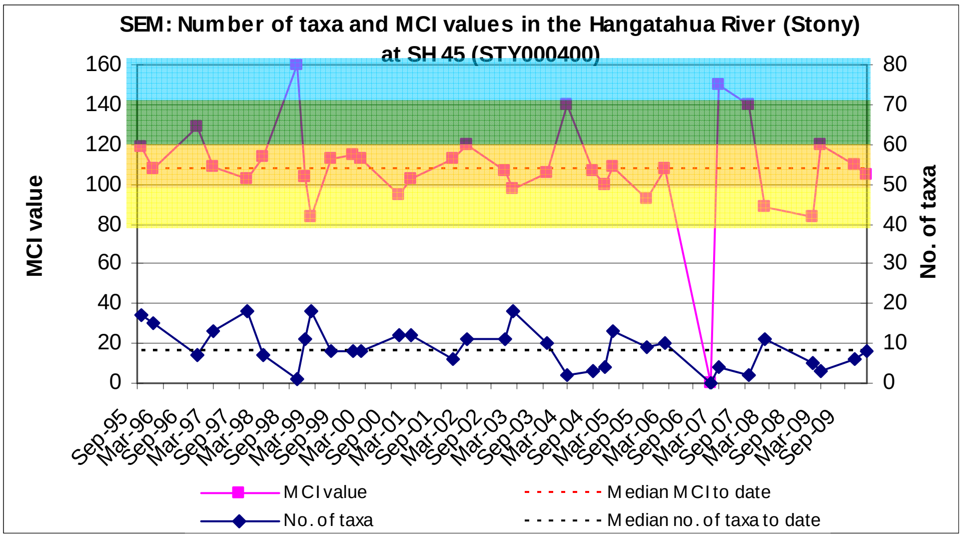


Figure 4 Numbers of taxa and MCI values in the Hangatahua (Stony) River at SH 45

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 9 taxa, far fewer than might be expected for a ringplain river site at this altitude (70 m asl). In the 2009-2010 period richness was slightly below this median, more so at the time of the spring sampling occasion, indicative of continuing erosion impacts of scouring, finer sediment deposition, and bed movement at this site.

While it is recognised that there may be significant limitations to the appropriateness of the MCI when community compositions are 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 108 units. The MCI scores in spring, 2009 (110 units) and summer, 2010 (105 units) were within an insignificant 3 units of the historical median (Figure 4) and categorised this site as having 'good' health generically (Table 1) and, in terms of predictive relationships (Table 2), 'well above expected' health in spring, 2009 and 'better than expected' health in summer, 2010 for the lower reaches of a ringplain river. The historical median score (108 units) categorised this site as having 'good' generic health, but 'well above expected' predictive health, for a lower river reach.

3.2.1.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 9.

Table 9 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Stony River at SH 45 between 1995 and March 2009 [31 surveys] and by the spring 2009 and summer 2010

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	1	3		
EPHEMEROPTERA	*Deleatidium*	8	20	65	A	VA
PLECOPTERA	*Zelandoperla*	8	7	23		
COLEOPTERA	Elmidae	6	5	16		
TRICHOPTERA	*Aoteapsyche*	4	5	16		
	Costachorema	7	4	13		
	Hydrobiosis	5	4	13		
	Oxyethira	2	1	3		
DIPTERA	*Aphrophila*	5	1	3		
	Eriopterini	5	1	3		
	Maoridiamesa	3	2	6	VA	
	Orthocladiinae	2	7	23	VA	

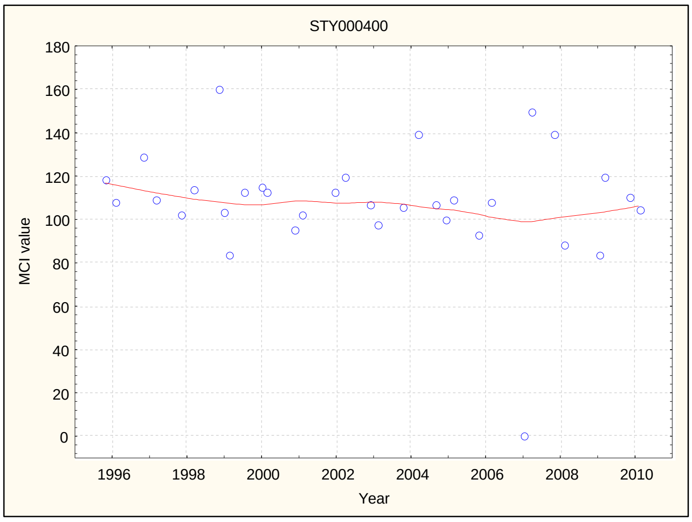
Prior to the current 2009-2010 period, twelve taxa have characterised this site's communities on occasions. These are comprised of two 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa. The predominant taxon has been a 'highly sensitive' taxon (the ubiquitous mayfly (*Deleatidium*)). This taxon is often present on unstable shingle-cobble substrates (Death, 2000) and during recovery from erosion/siltation events (Fowles, 1987). Three of these taxa (*Deleatidium* and 'tolerant' orthoclad midges and *Maoridiamesa*) were dominant in the spring community but only one taxon (*Deleatidium*) was abundant in the summer community; both these results indicative of a paucity of characteristic taxa due to preceeding headwater erosion impacts and substrate instability. The abundances of midges in spring was coincident with the presence of thin periphyton mats on the cobble-boulder substrate; an indication of improved substrate stability in the period preceeding this survey. These midge abundances were reflected in the low spring $SQMCI_s$ score (3.0 units) in comparison with the much higher summer $SQMCI_s$ score (7.4 units) when the 'highly sensitive' mayfly was the only characteristic taxon.

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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 92 (altitude) and 103 (distance) for this site. The historical site median (108 units) is significantly higher (Stark, 1998) than the altitude prediction and 5 units above the distance predictive value while both the spring, 2009 and summer, 2010 surveys' scores were higher but within 8 units of all predictive values. Of the 33 surveys to date at this site, only 9% of MCI scores have been less than 92 units while 70% have been greater than 103 units.

3.2.1.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Stony River at SH 45. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes (with the proviso noted earlier for this Stony River site). A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 5.



N = 33
Kendall tau = - 0.141
p level = 0.247 [>FDR, p = 0.401]
N/S at p <0.05

Figure 5 LOWESS trend plot of MCI data at SH 45 site

A gradually decreasing trend in MCI scores has not been statistically significant. The site has a LOWESS-smoothed MCI range of about 16 units indicative of some significant ecologically variability over the period for the same reasons as those responsible for variability at the upstream site (Mangatete Rd). Overall, smoothed scores have shown generic river 'health' (Table 1) within the 'good' grade while, in terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain river, 'health' has deteriorated slightly from 'well above expected' to 'better than expected', a similar trend to that found at the upstream, mid-reach (Mangatete Road) site. The majority of the variability in MCI scores has been associated with headwater erosion events.

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 have not been as pronounced as elsewhere in ringplain streams. Seasonal MCI values showed minor, if any, differences with only a small 5 unit decrease in scores at the downstream site under summer conditions and relatively minor characteristic taxa differences in a downstream direction and/or between seasons at both sites.

MCI scores atypically increased in a downstream direction in spring. A fall of 5 units in summer over a distance of 5.2 km, equating to a rate of decline of 1.0 unit/km, was very similar to the predicted rate (1.15 units/km) over the equivalent length of a National Park-sourced river (Stark and Fowles, 2009).

3.2.2 Timaru Stream

In the previous year, severe headwater erosion events have impacted upon the macroinvertebrate communities of the upper reaches of this stream in particular (TRC, 2009). The results found in the 2009-2010 surveys are presented in Table 128 and 129, Appendix I.

3.2.2.1 Carrington Road site (TMR000150)

3.2.2.1.1 Taxa richness and MCI

Twenty-eight 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 2009. These results are summarised in Table 10, together with the results from the current period, and illustrated in Figure 6.

Table 10 Results of previous surveys performed in the Timaru Stream at Carrington Road, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TMR000150	28	8 – 32	25	119-144	136	22	133	23	143

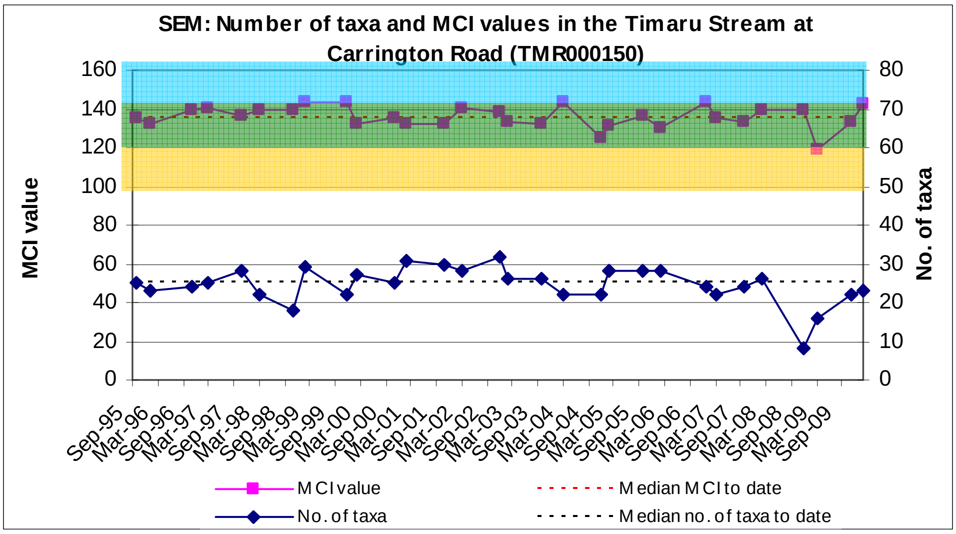


Figure 6 Numbers of taxa and MCI values in the Timaru Stream at Carrington Road

A wide range of richnesses (8 to 32 taxa) has been found; wider than might be expected, due to headwater erosion effects over the 2008-2009 period, with a median richness of 25 taxa (more representative of typical richnesses in ringplain streams and rivers near the National Park boundary). During the 2009-2010 period spring (22 taxa) and summer (23 taxa) richnesses were slightly lower than this median richness (during a post-headwater erosion recovery phase).

MCI values have had a slightly wider range (25 units) at this site than typical of a National Park boundary site, due in part to an atypically low value after the 2008-2009 headwater erosion period. The median value (136 units) has been typical of upper reach sites elsewhere on the ringplain however, and the spring, 2009 (133 units) and summer, 2010 (143 units) scores were typical for such a site, near to and 7 units above the historical median respectively. These scores categorised this site as having 'very good' (spring) and 'excellent' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected to 'better than expected' health for the upper reaches of a ringplain stream on these occasions respectively. The historical median score (136 units) placed this site in the 'very good' category for the generic, and 'better than expected' category for the predictive methods of assessment.

3.2.2.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 11.

Table 11 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Timaru Stream at Carrington Road between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of surveys	2009-2010 surveys	
					Spring 2009	Summer 2010
EPHEMEROPTERA	*Austroclima*	7	3	11		
	Coloburiscus	7	20	71		A
	Deleatidium	8	28	100	XA	VA
	Nesameletus	9	24	86	A	A
PLECOPTERA	*Acroperla*	5	4	14		
	Stenoperla	10	2	7		
	Zelandobius	5	22	79		
	Zelandoperla	8	16	57	VA	A
COLEOPTERA	Elmidae	6	12	43		
TRICHOPTERA	*Costachorema*	7	1	4		
	Hydrobiosis	5	0	0		A
	Hydrobiosella	9	3	11		
	Orthopsyche	9	2	7		
	Helicopsyche	10	4	14		
DIPTERA	*Aphrophila*	5	9	32		
	Maoridiamesa	3	2	7		
	Orthocladiinae	2	17	61		

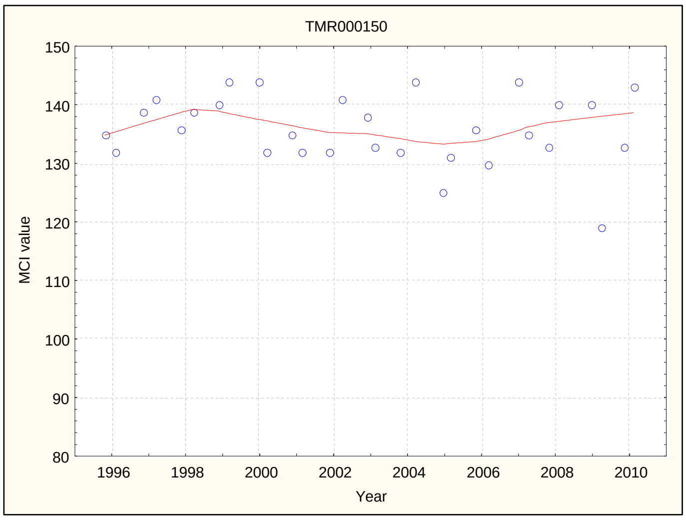
Prior to the current 2009-2010 period, 16 taxa had characterised the community at this site on occasions. These have comprised seven 'highly sensitive', seven 'moderately sensitive', and two 'tolerant' taxa i.e a majority of 'sensitive' taxa as would be expected near the National Park boundary of a ringplain stream. Predominant taxa have included three 'highly sensitive' taxa (mayflies ((*Deleatidium* on every sampling occasion) and *Nesameletus*) and stonefly (*Zelandoperla*)); four 'moderately sensitive' taxa (mayfly (*Coloburiscus*), stonefly (*Zelandobius*), elmid beetles, and cranefly (*Aphrophila*)), and one 'tolerant' taxon (orthoclad midges). Three of these taxa (all 'highly sensitive' taxa) were dominant in the spring, 2009 community. These same three taxa were again dominant in the summer, 2010 community together with one of the 'moderately sensitive' historically characteristic taxa of this site (mayfly (*Coloburiscus*)) and another 'moderately sensitive' taxon (caddisfly (*Hydrobiosis*)), which, although found at this site previously, had not been a characteristic taxon. No 'tolerant' taxa were dominant on either sampling occasion coincident with minimal periphyton substrate cover at this site. These similarities in characteristic community compositions were reflected in the minimal seasonal difference of 0.4 unit in $SQMCI_s$ values (Tables 128 and 129).

3.2.2.1.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 127 (altitude) and 132 (distance) for this site. The historical site median (136 units) is 9 units higher than the altitude prediction and 4 units higher than the distance predictive value. The spring score (133 units) was higher and within 6 units of both predictive values and the summer score (143 units) was significantly higher (Stark, 1998) than both predictive values. Of the 30 surveys to date at this site, only 7% of MCI scores have been less than 127 units while 70% have been greater than 132 units.

3.2.2.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Timaru Stream at Carrington Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 7.



N = 30
Kendall tau = -0.088
p level = 0.495 [>FDR,p = 0.662]
N/S at p <0.05

Figure 7 LOWESS trend plot of MCI data at the Carrington Road site

MCI scores have trended very slightly downwards in general, with a more recent improvement, but the trend has not been statistically significant over the period. The LOWESS-smoothed MCI scores have ranged over 6 units which has not been ecologically significant. Smoothed scores have been indicative of 'very good' generic stream health (Table 1) throughout the period and, in terms of predictive relationships (Table 2) for a site in the upper reaches of a ringplain stream at the boundary of the National Park, stream health has remained 'better than expected' almost throughout the fifteen year period.

3.2.2.2 SH45 site (TMR000375)

3.2.2.2.1 Taxa richness and MCI

Twenty eight surveys have been undertaken in the Timaru Stream at this lower, mid-reach site at SH45 between October 1995 and mid February 2009. These results are summarised in Table 12, together with the results from the current period, and illustrated in Figure 10.

Table 12 Results of previous surveys performed in the Timaru Stream at SH45, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TMR000375	28	13-33	26	89-120	100	21	120	31	114

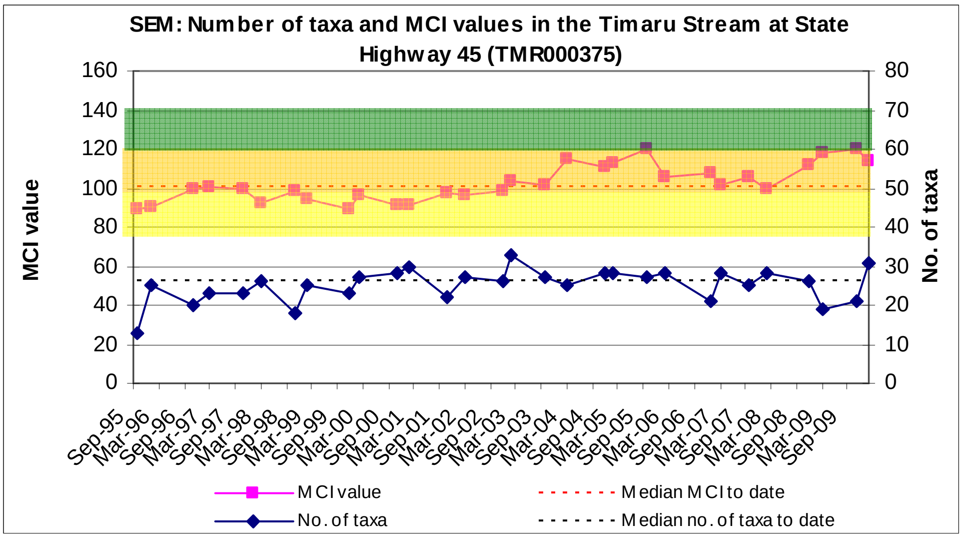


Figure 8 Numbers of taxa and MCI values in the Timaru Stream at State Highway 45

A wide range of richnesses (13 to 33 taxa) has been found; wider than might be expected, with a median richness of 26 taxa (more representative of typical richnesses in the mid reaches of ringplain streams and rivers). During the 2009-2010 period spring (21 taxa) and summer (31 taxa) richnesses were quite different (by 10 taxa); slightly lower than the median taxa number in spring, but near maximum richness in summer, when substrate periphyton cover was more extensive.

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 (100 units) has been relatively typical of mid reach sites elsewhere on the ringplain however, but the spring 2009 (120 units) and summer (114 units) scores were well above those typical for such a site and significantly higher than the historical median by 20 and 14 units respectively. These scores categorised this site as having 'very good' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the mid reaches of a ringplain stream. The historical median score (100 units) placed this site in the 'good' category for the generic and 'expected' category for the predictive methods of assessment.

3.2.2.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 13.

Table 13 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Timaru Stream at SH45 between 1995 and February 2009 [28 surveys] , and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	2009-2010 surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	1	4		
ANNELIDA	Oligochaeta	1	12	43		
MOLLUSCA	*Potamopyrgus*	4	4	14		
EPHEMEROPTERA	*Austroclima*	7	8	29	A	
	Coloburiscus	7	15	54	A	VA
	Deleatidium	8	10	36	A	
	Rallidens	9	1	4		
PLECOPTERA	*Acroperla*	5	5	18		
	Zelandobius	5	1	4		
	Zelandoperla	8	10	36		A
COLEOPTERA	Elmidae	6	11	39	A	VA
MEGALOPTERA	*Archichauliodes*	7	8	29	A	A
TRICHOPTERA	*Aoteapsyche*	4	25	89	A	XA
	Costachorema	7	10	36		A
	Hydrobiosis	5	6	21		A
	Neurochorema	6	4	14		A
	Beraeoptera	8	2	7		
	Confluens	5	1	4		
	Oxyethira	2	7	25		
	Pycnocentrodes	5	11	39	A	
DIPTERA	*Aphrophila*	5	26	93	VA	VA
	Maoridiamesa	3	22	79	VA	A
	Orthocladiinae	2	28	100	VA	VA
	Tanytarsini	3	6	21		
	Empididae	3	5	18		
	Muscidae	3	4	14		
	Austrosimulium	3	12	43		

Prior to the current 2009-2010 period, 27 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 an increased proportion of 'tolerant' taxa as would be expected in the mid reaches of a ringplain stream. Predominant taxa have included two 'highly sensitive' taxa (mayfly ((*Deleatidium*) and stonefly (*Zelandoperla*)); five 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Costachorema*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)), and five 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*)), midges (*Maoridiamesa* and orthoclads), and sandfly (*Austrosimulium*)). Ten of the historically characteristic taxa were dominant in the spring 2009 community. These comprised one 'highly sensitive' taxon, six 'moderately sensitive' and three 'tolerant' taxa, whereas one 'highly sensitive', seven 'moderately sensitive', and three 'tolerant' taxa comprised the dominant taxa of the summer community. Seven of these 15 taxa were dominant in both spring and summer communities (Table 13) and this was reflected in the similarities in seasonal $SQMCI_s$ scores (Table 128 and 129) which differed by only 0.3 unit.

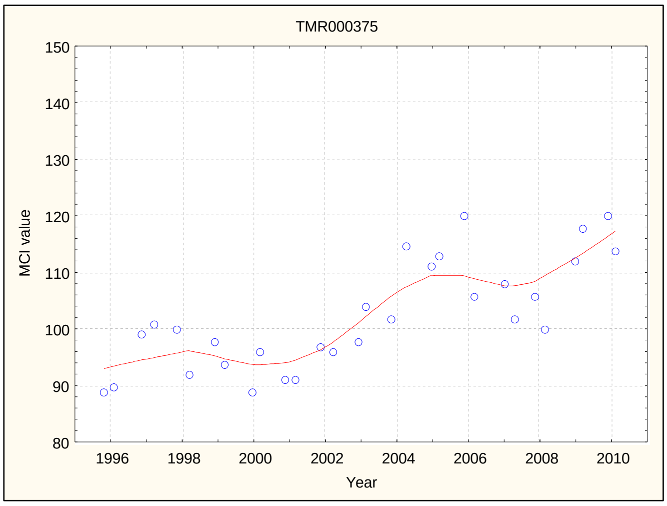
The 'moderately sensitive' cranefly (*Aphrophila*) and 'tolerant' midges (orthoclads and *Maoridiamesa*) and 'tolerant' caddisfly (*Aoteapsyche*) have characterised this site's communities on more than 78% of past survey occasions and were dominant in spring and summer surveys.

3.2.2.2.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 95 (altitude) and 105 (distance) for this site. The historical site median (100) is 5 units higher than the altitude prediction and 5 units lower than the distance predictive value. The spring survey score (120 units) was significantly higher than both predictive values while the summer score (114 units) was significantly higher (Stark, 1998) than the predictive altitude value. Of the 30 surveys to date at this site, 25% of MCI scores have been less than 95 units while 39% have been greater than 105 units.

3.2.2.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Timaru Stream at SH45. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 9.



N = 30
Kendall tau = +0.573
p level < 0.0001 [>FDR,p <0.001]
Significant at p <0.05 and p <0.01 after FDR

Figure 9 LOWESS trend plot at the SH45 site

MCI scores have shown a strong temporal trend of improvement (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 LOWESS-smoothed scores have ranged over 24 units, an ecologically significant range. No obvious explanations have been apparent for the trend but a possible reason may be related to improved management of dairy shed wastes disposal in the catchment above this SH45 site. Smoothed MCI scores have indicated an improvement in generic stream 'health' (Table 1) from 'fair' to 'good', where it currently remains. In terms of predictive relationships (Table 2) for a site toward the lower end of the mid reaches of a ringplain stream, stream health has improved from 'expected' to 'better than expected' where it has remained since 2003.

3.2.2.3 Discussion

Seasonal MCI values atypically improved between spring and summer at the National Park boundary site whereas a more typical decrease (of 6 units) was found at the mid reach site where the percentage composition of 'tolerant' taxa increased in the summer community. Seasonal communities at the upper site shared 19 common taxa (73% of the 26 taxa found at this site in 2009-2010) compared with 18 shared common taxa (55% of the 33 taxa found in the 2009-2010) at the mid reaches site (SH45), a more pronounced seasonal change in community structure at the further downstream site. The two sites shared only 11 common taxa (34% of the 32 taxa at upper and mid reach sites) in spring and 16 common taxa (42% of 38 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and summer.

MCI score typically fell in a downstream direction in both spring (by 13 units) and more markedly in summer (by 29 units), over a stream distance of 10.9 km downstream from the National Park boundary.These equated to rates of decline of 1.2 units/km in spring increasing to 2.7 units/km in summer, compared with a predicted rate of 2.4 units/km over the equivalent length and reach of a National Park-sourced stream (Stark and Fowles, 2009).

Using the long-term median SEM MCI scores for both sites (Appendix II), the rate of decline between the upper and lower reach sites has been 3.2 units/km over the surveyed length. Therefore rates of decline in both spring and summer of the 2009 – 2010 period were lower than typical rates for the 1995 to 2009 period.

3.2.3 Mangaoraka Stream

The results found by the 2009-2010 surveys are presented in Tables 130 and 131, Appendix I.

3.2.3.1 Corbett Road site (MRK000420)

3.2.3.1.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken at this lower reach site in the Mangaoraka Stream between October 1995 and February 2009. These results are summarised in Table 14, together with the results from the current period, and illustrated in Figure 10.

Table 14 Results of previous surveys performed in Mangaoraka Stream at Corbett Road, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MRK000420	28	11-30	25	75-104	89	22	105	25	102

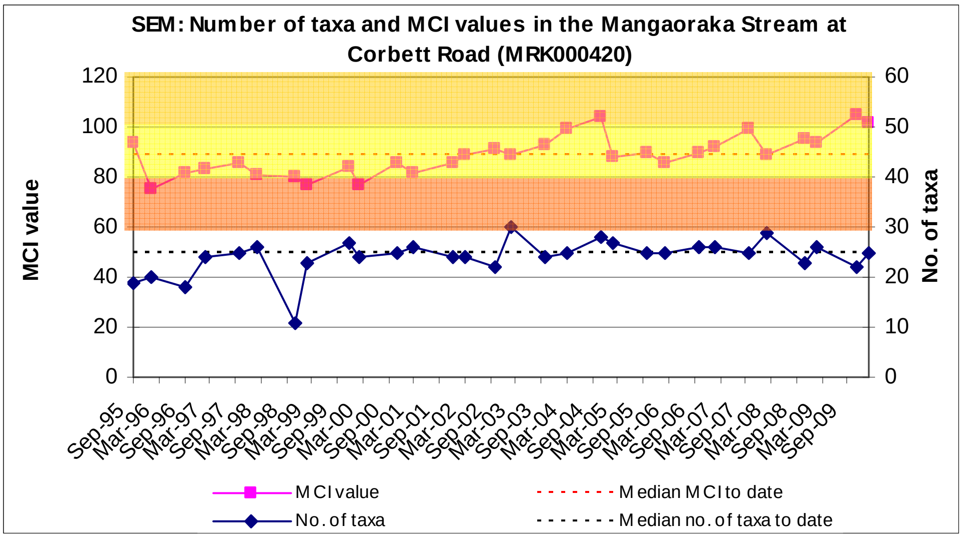


Figure 10 Numbers of taxa and MCI values in the Mangaoraka Stream at Corbett Road

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 ringplain streams rising outside the National Park boundary). During the 2009-2010 period spring (22 taxa) and summer (25 taxa) richnesses were relatively similar and slightly lower than or equivalent to this median richness.

MCI values have had a relatively wide range (29 units) at this site. The median value (89 units) has been typical of lower reach sites elsewhere on the ringplain however, but the spring, 2009 (105 units) and summer, 2010 (102 units) scores were higher than typical for such a site; significantly (Stark, 1998) 16 and 13 units above the historical median respectively. The spring value was one MCI unit higher than previously recorded at this site. These scores categorised this site as having ‘good’ (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table

2), 'better than expected' health for the lower reaches of a ringplain stream on both these occasions. The historical median score (89 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.3.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 15.

Table 15 Characteristic taxa (abundant, very abundant, extrememly abundant) recorded in the Mangaoraka Stream at Corbett Road, between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
PLATYHELMINTHES	*Cura*	3	1	4		
NEMERTEA	Nemertea	3	4	14		
ANNELIDA	Oligochaeta	1	21	75	A	A
MOLLUSCA	*Latia*	5	2	7		
	Physa	3	1	4		
	Potamopyrgus	4	24	86	VA	A
CRUSTACEA	Ostracoda	1	1	4		
EPHEMEROPTERA	*Austroclima*	7	14	50	VA	VA
	Coloburiscus	7	3	11	A	
	Deleatidium	8	1	4	A	
	Zephlebia group	7	1	4	A	
PLECOPTERA	*Zelandobius*	5	10	36	VA	
COLEOPTERA	Elmidae	6	16	57	XA	XA
MEGALOPTERA	*Archichauliodes*	7	9	32	A	A
TRICHOPTERA	*Aoteapsyche*	4	23	82	VA	VA
	Costachorema	7	2	7		
	Hydrobiosis	5	21	75		A
	Neurochorema	6	2	7		
	Oxyethira	2	6	21		
	Pycnocentria	7	2	7		
	Pycnocentrodes	5	19	68	XA	A
DIPTERA	*Aphrophila*	5	15	54		A
	Maoridiamesa	3	7	25	A	
	Orthocladiinae	2	24	86		A
	Tanytarsini	3	6	21		A
	Empididae	3	4	14		
	Muscidae	3	2	7		
	Austrosimulium	3	10	36		

Prior to the current 2009-2010 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 seven 'moderately sensitive' taxa (mayfly (*Austroclima),* stonefly (*Zelandobius*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)), and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), orthoclad midges, and sandfly (*Austrosimulium*)).

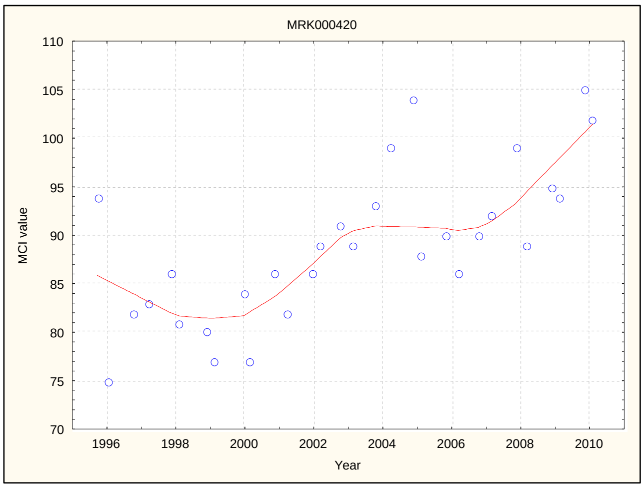
Twelve of the historically characteristic taxa were dominant in the spring, 2009 community and comprised eight of the predominant taxa (above) together with one 'highly sensitive' and two 'moderately sensitive' mayfly taxa and one 'tolerant' midge taxon. The summer, 2010 community was characterised by seven of the taxa dominant in spring, together with an additional three 'moderately sensitive' and two 'tolerant' (midge) taxa, all of which previously had been characteristic of this site's communities (Table 15). The relative similarity in seasonal dominant taxa was reflected in the minimal difference in $SQMCI_s$ scores of 0.1 unit (Tables 130 and 131). All taxa which were recorded as very or extremely abundant during spring and/ or summer had characterised this site's communities on 36% to 86% of past surveys.

3.2.3.1.3 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. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 91 units for this site. The historical site median (89 units) is only 2 units below this altitude prediction while both the spring survey score (105 units) and the summer score (102 units) were significantly higher (Stark, 1998) than the predictive value. Of the 30 surveys to date at this site, 77% of MCI scores have been less than 91 units, indicating that the current spring and summer MCI scores were not typical of historical conditions.

3.2.3.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Mangaoraka Stream at Corbett Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 11.



N = 30
Kendall tau = + 0.568
p level < 0.001 [>FDR,p <0.001]
Significant at p <0.05 and p <0.01 after FDR application

Figure 11 LOWESS trend plot at the Corbett Road site

This site's MCI scores have shown a strong, statistically significant improvement ($p < 0.01$ after FDR), particularly since 1999 with the trend tending to plateau between 2003 and 2007 before improving strongly more recently. These latest scores remain above scores recorded prior to 2000. The trend was statistically significant after FDR application. The LOWESS-smoothed scores have varied over an ecologically significant range of 20 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, poorer overall water quality has been recorded despite the apparent improvement in biological communities.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) throughout the period and, in terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, health has improved from 'expected' to 'better than expected' (since 2003) over the fifteen year period.

3.2.3.2 Discussion

Seasonal MCI values typically decreased between spring and summer (but only by 3 units) at this lower reach site where the percentage composition of 'tolerant' taxa increased by 8% in the summer community when periphyton mats and filamentous algal substrate cover was more pronounced under much warmer water temperature conditions. Seasonal communities at this site shared 19 common taxa (68% of the 28 taxa found at this site in 2009-2010), a relatively high percentage of common taxa thereby accounting for the similarity in MCI values.

3.2.4 Waiongana Stream

The results found by the 2009-2010 surveys are presented in Table 132 and Table 133, Appendix I.

3.2.4.1 State Highway 3a site (WGA000260)

3.2.4.1.1 Taxa richness and MCI

Twenty-nine surveys have been undertaken at this mid reach site in the Waiongana Stream between October 1995 and February 2009. These results are summarised in Table 16, together with the results from the current period, and illustrated in Figure 12.

Table 16 Results of previous surveys performed in the Waiongana Stream at SH3a prior to the spring 2009 survey, together with spring 2009 and summer 2010

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGA000260	29	12-30	24	82-112	94	24	101	26	106

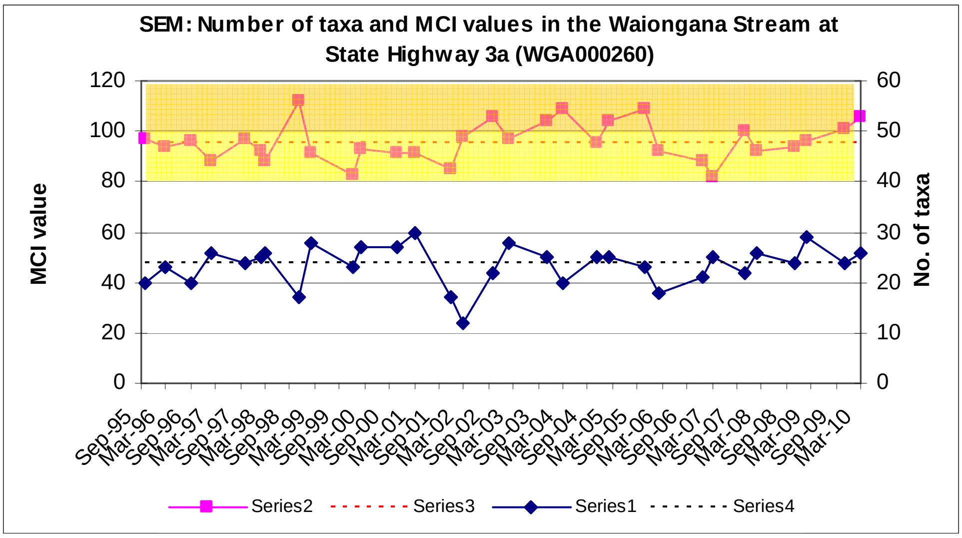


Figure 12 Numbers of taxa and MCI values in the Waiongana Stream at State Highway 3A

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 2009-2010 period, spring (24 taxa) and summer (26 taxa) richnesses were similar and very close to this median richness.

MCI values have 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 (94 units) also has been typical of mid-reach sites elsewhere on the ringplain, and the spring, 2009 (101 units) and summer, 2010 (106 units) scores were 7 and a significant 12 units above the historical median respectively. These scores categorised this site as having 'good' health generically (Table 1) in both spring and summer and, in terms of predictive relationships (Table 2), 'better than expected' health for the mid reaches of a ringplain stream on both of these occasions. The historical median score (94 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.4.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 17.

Table 17 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiongana Stream at SH3a between 1995 and February 2009 [29 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	2	7		
ANNELIDA	Oligochaeta	1	17	59		
MOLLUSCA	*Potamopyrgus*	4	11	38		
CRUSTACEA	*Paracalliope*	5	1	3		
EPHEMEROPTERA	*Austroclima*	7	2	7		
	Coloburiscus	7	3	10		
	Deleatidium	8	10	34	XA	VA
COLEOPTERA	Elmidae	6	20	69	VA	VA
MEGALOPTERA	*Archichauliodes*	7	6	21		A
TRICHOPTERA	*Aoteapsyche*	4	18	62	A	VA
	Costachorema	7	7	24	A	
	Hydrobiosis	5	13	45		A
	Neurochorema	6	2	7		
	Oxyethira	2	9	31		
	Pycnocentrodes	5	5	17	A	A
DIPTERA	*Aphrophila*	5	23	79	VA	A
	Maoridiamesa	3	19	66	VA	
	Orthocladiinae	2	25	86	XA	VA
	Tanytarsini	3	10	34		VA
	Empididae	3	6	21		
	Muscidae	3	6	21		
	Austrosimulium	3	2	7		A

Prior to the current 2009-2010 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 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*)); three 'moderately sensitive' taxa (elmid beetles, free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)); and seven 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), algal-piercing caddisfly (*Oxyethira*), and midges (*Maoridiamesa*, orthoclads, and tanytarsids)). Six of these predominant taxa were dominant in the spring, 2009 community together with two of the other historically characteristic taxa. The summer, 2010 community was characterised by six of the taxa dominant in spring, together with an additional two 'moderately sensitive' and two 'tolerant' taxa, all of which previously had been characteristic of this site's communities (Table 17). The relative similarity in seasonal dominant taxa was reflected in the minimal difference (0.2 unit) in $SQMCI_s$ scores (Tables 132 and 133).

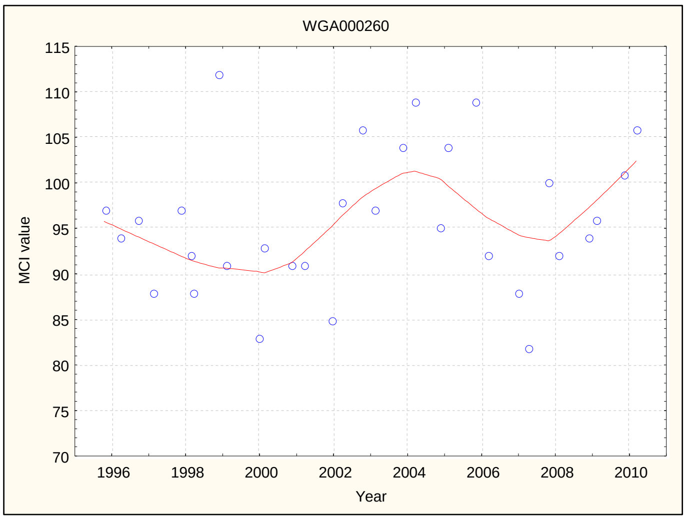
All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 34% to 86% of past surveys.

3.2.4.1.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 99 (altitude) and 100 (distance) for this site. The historical site median (94 units) is 5 units lower than the altitude prediction and 6 units below the distance predictive value, while the spring, 2009 survey score (101 units) was slightly higher by 1 to 2 units than both predictive values while the summer, 2010 score (106 units) was slightly higher again (by 6 to 7 units) than both predictive values. Of the 31 surveys to date at this site, 71% of MCI scores have been less than 99 units while only 23% have been greater than 100 units.

3.2.4.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Waiongana Stream at SH3a. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 13.



N = 31
Kendall tau = + 0.140
p level = 0.268 [>FDR, p = 0.422]
N/S at $p < 0.05$

Figure 13 LOWESS trend plot of MCI data at the SH3a site

There was a small positive overall trend in the MCI scores identified, which had no statistical significance. There was a steady improvement in scores beween 2001 and 2004 followed by a decline in scores until 2008, and a steady increase to date. This site's scores have had a LOWESS-smoothed range of 12 units indicative of marginal ecologically significant variability over the period.

Overall, smoothed scores remained indicative of 'fair' generic stream health (Table 1) for the majority of the period, improving to 'good' 'health' briefly in 2003 to 2005 returning to 'fair' until very recently.

In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain stream, stream health has been 'expected' almost throughout the fifteen year period, bordering on 'better than expected' for short periods in 2003-2005 and most recently in 2009-2010.

3.2.4.2 Devon Road site (WGA000450)

3.2.4.2.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken at this lower reach site at SH45 in the Waiongana Stream between October 1995 and February 2009. These results are summarised in Table 18, together with the results from the current period, and illustrated in Figure 14.

Table 18 Results of previous surveys performed in the Waiongana Stream at Devon Road prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGA000450	28	12-29	22	72-102	84	23	93	15	91

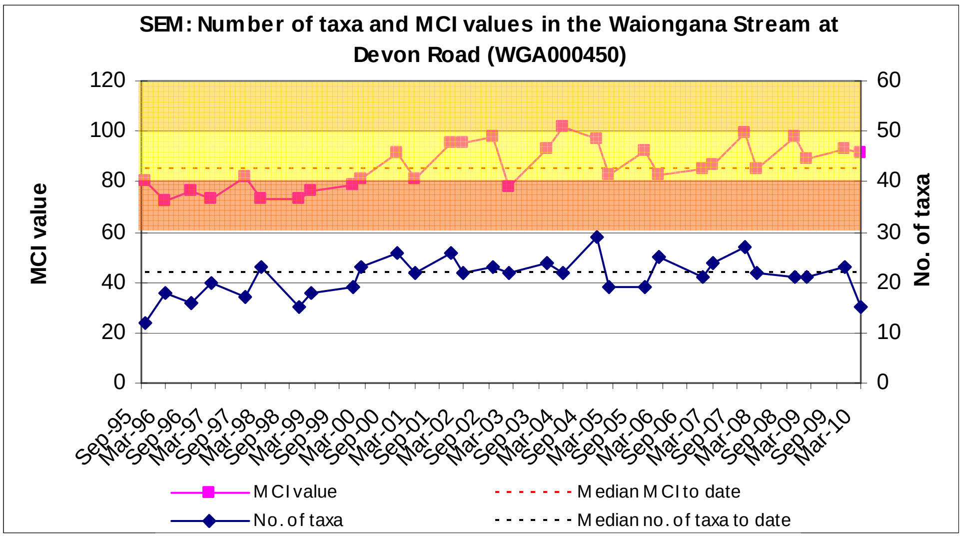


Figure 14 Numbers of taxa and MCI values in the Waiongana Stream at Devon Road

A wide range of richness (12 to 29 taxa) has been found; wider than might be expected with a median richness of 22 taxa and more representative of typical richnesses in ringplain streams and rivers in the lower reaches. During the 2009-2010 period, spring (23 taxa) and summer (15 taxa) richnesses were quite different (by 8 taxa); very similar to the median taxa number in spring but nearer the minimum richness in summer, despite similar substrate periphyton cover on both occasions.

MCI scores have had a relatively wide range (30 units) at this site more typical of sites in the lower reaches of ringplain streams. The median value (84 units) has been relatively typical of lower reach sites elsewhere on the ringplain however, but the spring, 2009 (93 units) and summer, 2010 (91 units) scores were within the range typical for such a site and higher than the historical median by 9 and 7 units respectively. These scores categorized this site as having 'fair' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the lower reaches of a ringplain stream. The historical median score (84 units) placed this site in the 'fair' category for generic and 'expected' category for pred`ictive methods of assessment.

3.2.4.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 19.

Table 19 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiongana Stream at Devon Road between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	3	11		
ANNELIDA	Oligochaeta	1	22	79	VA	VA
MOLLUSCA	*Ferrissia*	3	1	4		
	Latia	5	1	4		A
	Potamopyrgus	4	16	57	VA	XA
CRUSTACEA	*Paracalliope*	5	2	7		
	Paratya	3	1	4		
EPHEMEROPTERA	*Austroclima*	7	3	11		A
	Deleatidium	8	4	14		
COLEOPTERA	Elmidae	6	9	32	VA	VA
MEGALOPTERA	*Archichauliodes*	7	4	14		A
TRICHOPTERA	*Aoteapsyche*	4	17	61	VA	XA
	Costachorema	7	2	7		
	Hydrobiosis	5	11	39		A
	Oxyethira	2	8	29		
	Pycnocentrodes	5	12	43	VA	
DIPTERA	*Aphrophila*	5	13	46	A	
	Maoridiamesa	3	12	43	A	
	Orthocladiinae	2	24	86	A	A
	Tanytarsini	3	9	32		VA
	Empididae	3	1	4		
	Muscidae	3	3	11		
	Austrosimulium	3	6	21		

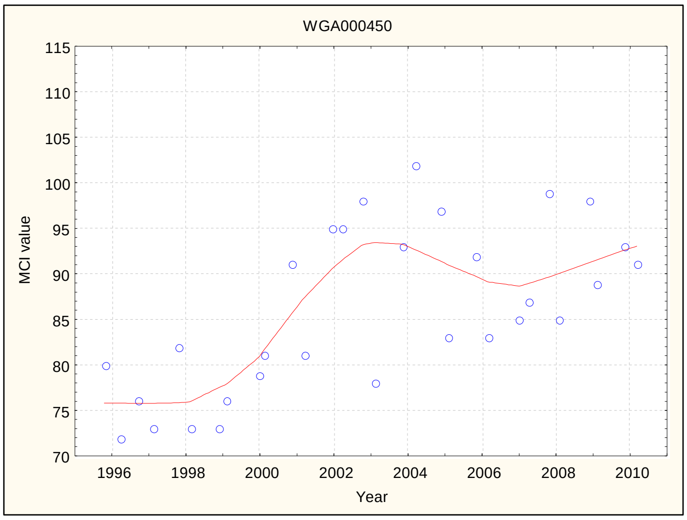
Prior to the current 2009-2010 period 23 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', nine 'moderately sensitive', and 13 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly sensitive' taxa; four 'moderately sensitive' taxa (elmid beetles, free-living caddisfly (*Hydrobiosis*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)), and six 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (orthoclads, tanytarsids, and *Maoridiamesa*)). Eight of the historically characteristic taxa were dominant in the spring 2009, community. These comprised three 'moderately sensitive' and five 'tolerant' taxa, whereas five 'moderately sensitive' and five 'tolerant' taxa comprised the dominant taxa in the summer community. Five of these 13 taxa were dominant in both spring and summer communities (Table 19). The relative similarity in the very abundant taxa in both seasons was reflected in the minimal difference (0.1 unit) in $SQMCI_s$ scores (Tables 132 and 133). All taxa recorded as very or extremely abundant during spring and /or summer had characterised this site's communities on 32% to 79% of past surveys.

3.2.4.2.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 86 (altitude) and 93 (distance) for this site. The historical site median (84 units) is slightly lower (by 2 units) than the altitude prediction and 9 units lower than the predictive distance value, while the spring, 2009 survey score (93 units) was slightly higher or equal with these predictive values. The summer, 2010 score (91 units) was higher than the predictive altitude value. Of the 30 surveys to date at this site 53% of MCI scores have been less than 86 units while only 23% have been greater than 93 units.

3.2.4.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site, in the Waiongana Stream at Devon Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 15.



N = 30
Kendall tau = + 0.484
p level < 0.0002 [>FDR, p = 0.0001]
Significant at p < 0.05 and p < 0.01
after FDR application

Figure 15 Lowess trend plot at the Devon Road site

MCI scores at this site have shown a statistically significant, strong temporal improvement over the period, despite some lowering of scores since 2004. However, these more recent scores remain well above those recorded over the first five years of the period. The LOWESS-smoothed scores have varied over an ecologically significant range of 18 units. Improvement has been coincident with a reduction in consented NPDC water abstraction and more rigorous control of an upstream large piggery's wastes disposal loadings to 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, particularly since 1999, indicating that activities in the catchment between these two sites have had a significant influence.

Overall smoothed MCI scores have indicated an improvement in generic stream 'health' (Table 1) from consistently 'poor' prior to 2000 to 'fair' where it has remained over the last ten years. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, the stream health has improved from 'worse than expected' through 'expected' to 'better than expected' where it has remained since 2002.

3.2.4.3 Discussion

Seasonal MCI values atypically improved between spring and summer at the mid-reach (SH3a) site whereas a more typical decrease (of 2 units) was found at the lower reach site where the percentage composition of 'tolerant' taxa increased slightly in the summer community. Seasonal communities at the mid-reach site (SH3a) shared 17 common taxa (47% of the 36 taxa found at this site in 2009-2010) compared with 14 shared common taxa (58% of the 24 taxa found in 2009-2010) at the lower reaches site (Devon Road), a more pronounced seasonal change in community structure at the mid-reach site. The two sites shared 15 common taxa (50% of the 30 taxa) in spring and only 11 common taxa (38% of 29 taxa) in summer, indicative of the dissimilarity in spatial community structures in spring and more particulary in summer.

MCI score typically fell in a downstream direction in both spring (by 8 units) and more markedly in summer (by 15 units), over a stream distance of 15.1 km downstream from the National Park boundary.These falls in MCI scores equated to rates of decline of 0.5 unit/km in spring increasing to 1.0 unit/km in summer, compared with a predicted rate of 0.5 unit/km over the equivalent length and reach of a National Park-sourced stream (Stark and Fowles, 2009).

Using the long-term median SEM MCI scores for both sites (Appendix II), the rate of overall decline has been 0.7 MCI units/km over the surveyed length. Therefore rates of decline over the 2009 – 2010 period were lower in spring and higher in summer than have been typical of rates prior to 2010.

3.2.5 Waiwhakaiho River

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. The results from the 2009-2010 surveys are presented in Table 134 and Table 135, Appendix I.

3.2.5.1 National Park site (WKH000100)

3.2.5.1.1 Taxa richness and MCI

Fourteen surveys have been undertaken at this upper reach site just inside the National Park boundary in the Waiwhakaiho River between November 2002 and March 2009. These results are summarised in Table 20, together with the results from the current period, and illustrated in Figure 16.

Table 20 Results of previous surveys performed in the Waiwhakaiho River at National Park, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000100	14	4-29	21	121-146	129	12	115	18	120

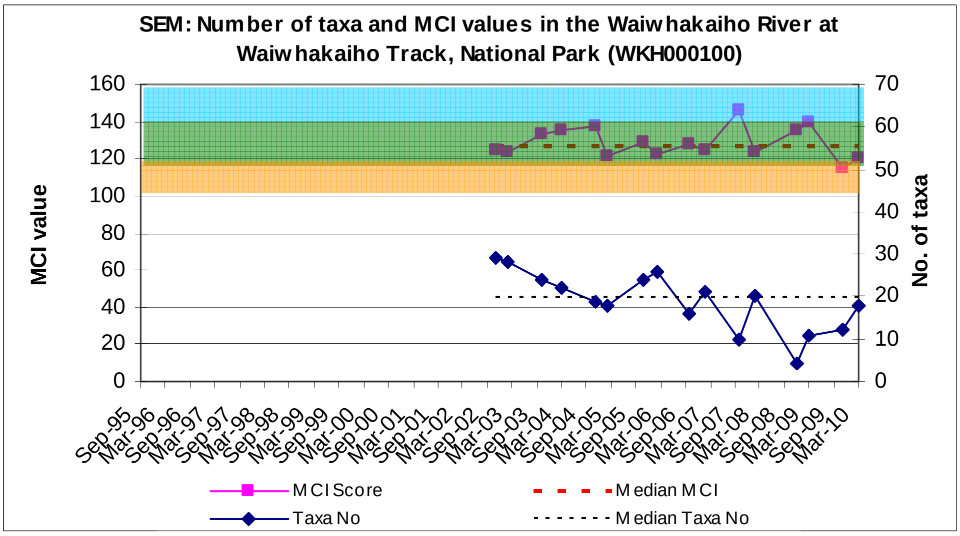


Figure 16 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmond National Park

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 21 taxa, but lower than typical richnesses in ringplain streams and rivers near the National Park boundary. During the 2009-2010 period spring (12 taxa) and summer (18 taxa) richnesses continued to be lower than this median richness during a post-headwater erosion recovery phase although evidence of siltation remained at this site.

MCI values have had a slightly wider range (25 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 again after the 2008-2009 headwater erosion period. The median value (129 units) has been slightly lower than typical of upper reach sites elsewhere on the ringplain, and the spring, 2009 (115 units) and summer, 2010 (120 units) scores continued this atypical trend for such a site. These scores were 14 and 9 units below the historical median respectively. They categorised this site as having 'good' (spring) and 'very good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'well below expected' to 'worse than expected' health for the upper reaches of a ringplain stream on these occasions respectively although taxa richnesses were indicative of only partial post-headwater erosion recovery. The historical median score (129 units) placed this site in the 'very good' and 'worse than expected' categories for generic and predictive methods of assessment respectively.

3.2.5.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 21.

Table 21 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at the National Park between 1995 and March 2009 [14 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
EPHEMEROPTERA	*Coloburiscus*	7	2	14		
	Deleatidium	8	14	100	VA	XA
	Nesameletus	9	4	29		
PLECOPTERA	*Megaleptoperla*	9	6	43		
	Zelandoperla	8	10	71		XA
COLEOPTERA	Elmidae	6	13	93		VA
TRICHOPTERA	*Aoteapsyche*	4	1	7		
	Costachorema	7	0			A
	Hydrobiosella	9	1	7		
	Beraeoptera	8	4	29		
DIPTERA	*Aphrophila*	5	7	50		
	Eriopterini	5	3	21		
	Maoridiamesa	3	1	7		
	Orthocladiinae	2	2	14		

Prior to the current 2009-2010 period, 13 taxa had characterised the community at this site on occasions. These have comprised six 'highly sensitive', four '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 (mayfly (*Deleatidium* on every sampling occasion) and stoneflies (*Zelandoperla* and *Megaleptoperla*)); two 'moderately sensitive' taxa (elmid beetles and cranefly (*Aphrophila*)); but no 'tolerant' taxa. Only one of these taxa ('highly sensitive' *Deleatidium*) was dominant in the spring 2009 community. This same taxon was again (very) dominant in the summer 2010 community together with another of the 'highly sensitive' taxa (stonefly

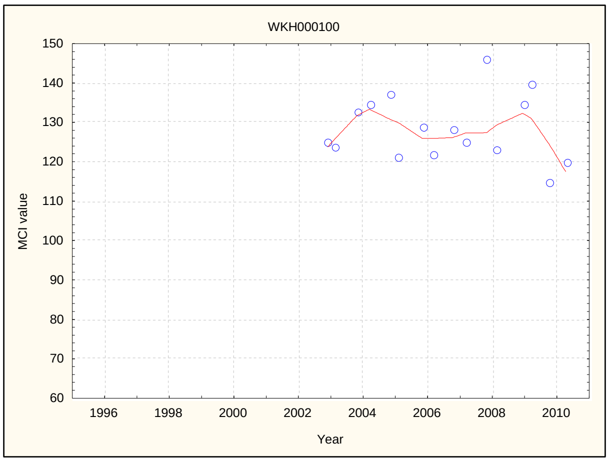
(*Zelandoperla*)), one of the 'moderately sensitive' historically characteristic taxa of this site (elmid beetles), and another 'moderately sensitive' taxon (caddisfly (*Costachorema*)), which, although found at this site previously, had not been a characteristic taxon. No 'tolerant' taxa were dominant on either sampling occasion coincident with minimal periphyton substrate cover at this site. All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 71% to 100% of past surveys.

3.2.5.1.3 Predicted stream 'health'

The Waiwhakaiho River site at the National Park is within the National Park boundary at an altitude of 460 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 131 (altitude) and 132 (distance) for this site. The historical site median (129 units) is only 2 units lower than the altitude prediction and 3 units lower than the distance predictive value, while the spring, 2009 survey score (115 units) was significantly lower than both predictive values and the summer, 2010 score (120 units) was also significantly lower (Stark, 1998) than both predictive values. Of the 16 surveys to date at this site, 63% of MCI scores have been less than 131 units while 37% have been greater than 132 units.

3.2.5.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the eight years of SEM results collected to date from the site in the Waiwhakaiho River at the National Park. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 17.



N = 16
Kendall tau = -0.084
p level = 0.650 [>FDR, p = 0.735]
N/S at $p < 0.05$

Figure 17 LOWESS trend plot of MCI data at the National Park site

No significant temporal trend in MCI scores has been found over the relatively short eight year monitoring period at this site within the National Park. Smoothed scores consistently have indicated 'very good' generic river health (Table 1) over the period but, in terms of predictive relationships (Table 2) for a site in the upper reaches of a ringplain river at the boundary of the National Park, river health has varied between 'expected' and 'worse than expected' for the majority of the eight year period.

3.2.5.2 Egmont Village site (WKH000500)

3.2.5.2.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken in the Waiwhakaiho River at this mid-reach site at SH 3, Egmont Village between October 1995 and March 2009. These results are summarised in Table 22, together with the results from the current period, and illustrated in Figure 18.

Table 22 Results of previous surveys performed in the Waiwhakaiho River at Egmont Village, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000500	28	14-32	24	87-122	108	23	103	18	112

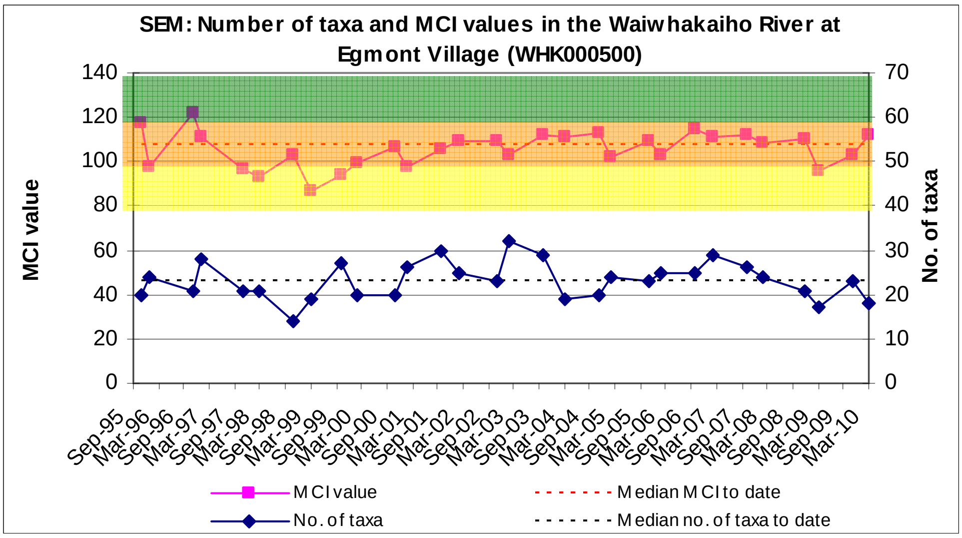


Figure 18 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont Village

A wide range of richnesses (14 to 32 taxa) has been found; wider than might be expected, with a median richness of 24 taxa (more representative of typical richnesses in the mid reaches of ringplain streams and rivers). During the 2009-2010 period spring (23 taxa) and summer (18 taxa) richnesses were slightly different (by 5 taxa); very similar to the median taxa number in spring, but nearer minimum richness in summer, when substrate periphyton cover was more extensive.

MCI values have had a slightly wider range (35 units) at this site than typical of sites in the mid reaches of ringplain rivers. The median value (108 units) has been relatively typical of mid reach sites elsewhere on the ringplain however, with the spring, 2009 (103 units) and summer, 2010 (112 units) scores typical for such a site and within 5 units of the historical median. These scores categorised this site as having 'good' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the mid reaches of a ringplain river. The historical median score (108 units) placed this site in the 'good' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.5.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 23.

Table 23 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at Egmont Village between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMATODA	Nematoda	3	1	4		
ANNELIDA	Oligochaeta	1	8	29		
EPHEMEROPTERA	*Coloburiscus*	7	9	32		
	Deleatidium	8	21	75	XA	XA
	Nesameletus	9	3	11		
PLECOPTERA	*Zelandoperla*	8	1	4		
COLEOPTERA	Elmidae	6	15	54		A
MEGALOPTERA	*Archichauliodes*	7	2	7		
TRICHOPTERA	*Aoteapsyche*	4	18	64		VA
	Costachorema	7	9	32		
	Hydrobiosis	5	4	14		
	Neurochorema	6	5	18		
	Beraeoptera	8	1	4		
	Oxyethira	2	8	29		
	Pycnocentrodes	5	3	11		
DIPTERA	*Aphrophila*	5	23	82	VA	A
	Eriopterini	5	2	7		
	Maoridiamesa	3	24	86	A	A
	Orthocladiinae	2	26	93	VA	VA
	Tanytarsini	3	10	36		
	Empididae	3	2	7		
	Muscidae	3	4	14		
	Austrosimulium	3	1	4		

Prior to the current 2009-2010 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 an 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 four 'tolerant' taxa (free-living caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa*, orthoclads, and tanytarsids)). Four of these historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive' taxon, one 'moderately sensitive' taxon, and two 'tolerant' taxa, whereas one 'highly sensitive', two 'moderately sensitive', and three 'tolerant' taxa comprised the dominant taxa of the summer community. Four of these six taxa were dominant in both spring and summer communities (Table 23). These relatively similar seasonal dominances were reflected in the minimal difference (0.2 unit) in $SQMCI_s$ scores (Tables 134 and 135).

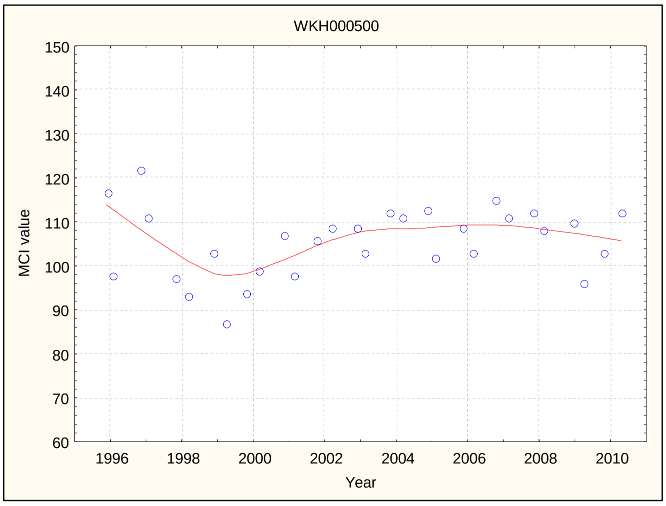
The 'highly sensitive' mayfly (*Deleatidium*), 'moderately sensitive' cranefly (*Aphrophila*), and 'tolerant' midges (orthoclads and *Maoridiamesa*) have characterised this site's communities on more than 75% of past survey occasions and were dominant in both the spring and summer surveys.

3.2.5.2.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 102 (altitude) and 105 (distance) for this site. The historical site median (108) is 6 units higher than the altitude prediction and 3 units higher than the distance predictive value while the spring, 2009 survey score (103 units) was within 2 units of both predictive values and the summer, 2010 score (112 units) was higher than both predictive values by 7 to 10 units. Of the 30 surveys to date at this site, 27 % of MCI scores have been less than 102 units while 57% have been greater than 105 units.

3.2.5.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Waiwhakaiho River at Egmont Village. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 19.



N = 30
Kendall tau = +0.185
p level = 0.151 [>FDR, p = 0.280]
N/S at p < 0.05

Figure 19 LOWESS trend plot at the Egmont Village site

No overall significant trend in MCI scores has been found during the fifteen year period. After some initial deterioration in scores, there has been a steady improvement since 1999. The LOWESS-smoothed range (16 MCI units) has been of marginal ecological significance over the period. While the smoothed scores were indicative of 'good' to 'fair' generic river health (Table 1) over the first five years, river health has consistently remained 'good' since 2000. In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain river, health has been 'better than expected' for all but one (early) year of the entire period.

3.2.5.3 Constance Street site (WKH000920)

3.2.5.3.1 Taxa richness and MCI

Twenty nine surveys have been undertaken in the Waiwhakaiho River at this lower reach site at Constance Street, New Plymouth between 1995 and March 2009. These results are summarised in Table 24, together with the results from the current period, and illustrated in Figure 20.

Table 24 Results of previous surveys performed in the Waiwhakaiho River at Constance Street, New Plymouth, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000920	29	12-29	22	71-108	93	19	94	20	95

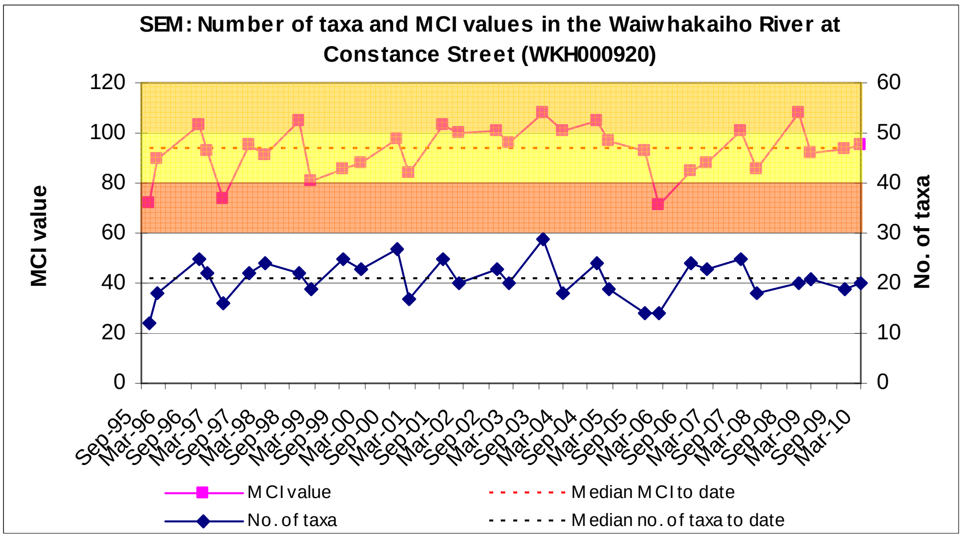


Figure 20 Numbers of taxa and MCI values in the Waiwhakaiho River at Constance Street

A wide range of richnesses (12 to 29 taxa) has been found with a median richness of 22 taxa (more representative of typical richnesses in the lower reaches of ringplain streams and rivers). During the 2009-2010 period spring (19 taxa) and summer (20 taxa) richnesses were very similar and slightly lower than the median taxa number on both occasions.

MCI values have had a wide range (37 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (93 units) has been relatively typical of the range of scores at lower reach sites elsewhere on the ringplain however. The spring, 2009 (94 units) and summer, 2010 (95 units) scores were very similar and typical of scores for such a site and within 2 units of the historical median. These scores categorised this site as having ‘fair’ health generically (Table 1) on both occasions and, in terms of predictive relationships (Table 2), ‘better than expected’ health on both occasions for the lower reaches of a ringplain river. The historical median score (93 units) placed this site in the ‘fair’ and ‘better than expected’ categories for generic and predictive methods of assessment respectively.

3.2.5.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 25.

Table 25 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at Constance Street between 1995 and March 2009 [29 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	1	3		
ANNELIDA	Oligochaeta	1	18	62	A	
MOLLUSCA	*Potamopyrgus*	4	2	7		
CRUSTACEA	*Paratya*	3	1	3		
EPHEMEROPTERA	*Coloburiscus*	7	5	17		
	Deleatidium	8	11	38	VA	A
COLEOPTERA	Elmidae	6	4	14		A
	Staphylinidae	5	1	3		
TRICHOPTERA	*Aoteapsyche*	4	22	76	A	VA
	Costachorema	7	5	17		
	Hydrobiosis	5	5	17		A
	Neurochorema	6	1	3		
	Oxyethira	2	10	34		
DIPTERA	*Aphrophila*	5	7	24		
	Maoridiamesa	3	13	45	VA	A
	Orthocladiinae	2	28	97	A	A
	Tanytarsini	3	14	48		A
	Muscidae	3	2	7		
	Austrosimulium	3	4	14		

Prior to the current 2009-2010 period, 19 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', seven 'moderately sensitive', and eleven '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 river. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); no 'moderately sensitive' taxa; and six 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), algal-piercing caddisfly (*Oxyethira*), and midges (*Maoridiamesa*, tanytarsids and orthoclads)). Five of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive' taxon and four 'tolerant' taxa, whereas one 'highly sensitive', two 'moderately sensitive', and four 'tolerant' taxa comprised the dominant taxa of the summer, 2010 community. Four of these eight taxa were dominant in both spring and summer communities (Table 25). The relatively similar seasonal dominances were reflected in the small difference (0.4 unit) in $SQMCI_s$ scores (Tables 134 and 135).

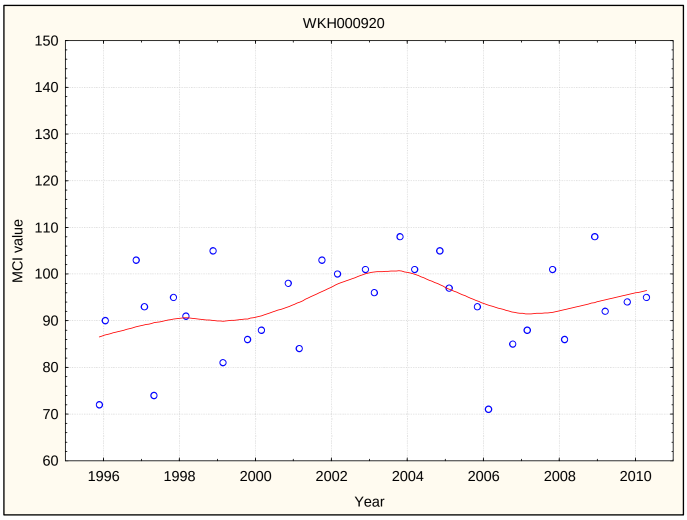
The 'highly sensitive' mayfly (*Deleatidium*) and 'tolerant' midges (orthoclads and *Maoridiamesa*) and 'tolerant' caddisfly (*Aoteapsyche*) have characterised this site's communities on more than 38% of past survey occasions and were dominant in spring and summer surveys.

3.2.5.3.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 86 (altitude) and 95 (distance) for this site. The historical site median (93) is 7 units higher than the altitude prediction and only two units lower than the distance predictive value. The spring, 2009 survey score (94 units) was 8 units higher than the altitude predictive value while the summer, 2010 score (95 units) was 9 units higher than the predictive altitude value and within one unit of the predicted distance value. Of the 31 surveys to date at this site, 19% of MCI scores have been less than 86 units while 39% have been greater than 95 units.

3.2.5.3.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2009) has been performed on the fifteen years of SEM results collected to date from the site in the Waiwhakaiho River at Constance Street . The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 21.



N = 31
Kendall tau = +0.124
p level = 0.327 [>FDR, p = 0.473]
N/S at $p < 0.05$

Figure 21 LOWESS trend plot at the Constance Street site

The overall trend in MCI scores has not been statistically significant for the period, due mainly to the more recent decline in score. The LOWESS-smoothed range of scores (14 units) indicates a degree of significant ecological variability. Smoothed MCI scores indicated 'fair' generic river health (Table 1) improving toward 'good' health (after a small increase in summer residual flow releases by TrustPower Mangorei HEP scheme) before returning to 'fair' health over the five most recent years. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, river health has improved from 'expected' early in the period to 'better than expected' where it has remained.

3.2.5.4 Site adjacent to Lake Rotomanu (WKH000950)

3.2.5.4.1 Taxa richness and MCI

Twenty-seven surveys have been undertaken in the Waiwhakaiho River at this lower reach site adjacent to Lake Rotomanu between March 1997 and March 2009. These results are summarised in Table 26, together with the results from the current period, and illustrated in Figure 22.

Table 26 Results of previous surveys performed in the Waiwhakaiho River the the site adjacent to Lake Rotomanu, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000950	27	12-27	21	70-111	87	22	88	18	97

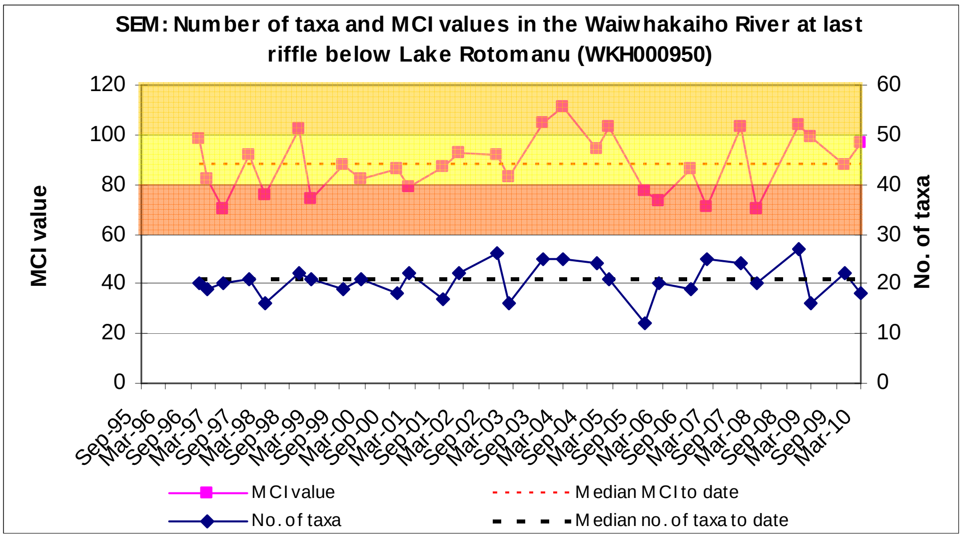


Figure 22 Numbers of taxa and MCI values in the Waiwhakaiho River at Lake Rotomanu

A wide range of richnesses (12 to 27 taxa) has been found; wider than might be expected, with a median richness of 21 taxa. During the 2009-2010 period spring (22 taxa) and summer (18 taxa) richnesses were relatively similar and within three taxa of the median richness.

MCI values have had a wide range (41 units) at this site but typical of sites in the lower reaches of ringplain streams. The median value (87 units) has been relatively typical of lower reach sites elsewhere on the ringplain. The spring 2009 (88 units) and summer, 2010 (97 units) scores were also typical for such a site and within 10 units of the historical median. These scores categorised this site as having 'fair' health generically (Table 1) on both occasions and, in terms of predictive relationships (Table 2), 'expected' health in spring and 'better than expected' health in summer for the lower reaches of a ringplain river. The historical median score (87 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.5.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 27.

Table 27 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at the site adjacent to Lake Rotomanu between 1995 and February 2009 [27 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	3	11		
ANNELIDA	Oligochaeta	1	23	85	XA	
MOLLUSCA	*Physa*	3	1	4		
	Potamopyrgus	4	6	22		
CRUSTACEA	*Paratya*	3	6	22		
EPHEMEROPTERA	*Coloburiscus*	7	1	4		
	Deleatidium	8	6	22	A	A
COLEOPTERA	Elmidae	6	1	4		A
TRICHOPTERA	*Aoteapsyche*	4	17	63	A	VA
	Costachorema	7	2	7		
	Hydrobiosis	5	3	11		
	Oxyethira	2	10	37		
DIPTERA	*Aphrophila*	5	8	30		
	Maoridiamesa	3	12	44	A	
	Orthocladiinae	2	27	100	VA	VA
	Tanytarsini	3	12	44		A
	Muscidae	3	1	4		
	Austrosimulium	3	1	4		

Prior to the current 2009-2010 period, 18 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', five 'moderately sensitive', and twelve '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' taxa; one 'moderately sensitive' taxon (cranefly (*Aphrophila*)); and six 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*)), algal-piercing caddisfly (*Oxyethira*), and midges (*Maoridiamesa*, tanytarsids and orthoclads)). Five of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive' taxon, no 'moderately sensitive' taxa, and four 'tolerant' taxa, whereas one 'highly sensitive', one 'moderately sensitive', and three 'tolerant' taxa comprised the dominant taxa of the summer, 2010 community. Only three of these 7 taxa were dominant in both spring and summer communities (Table 27) and this was reflected in the relatively large 2 unit increase in summer $SQMCI_s$ score (Tables 134 and 135), which was also due to a significant decrease in abundance of 'tolerant' oligochaete worms.

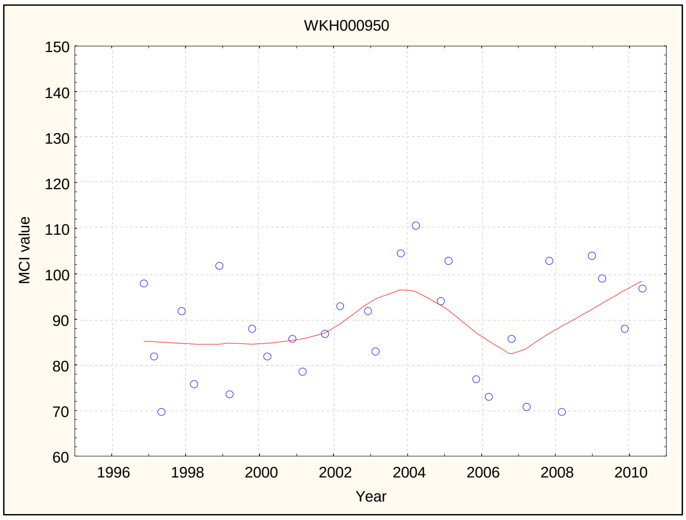
The 'highly sensitive' mayfly (*Deleatidium*), 'moderately sensitive' caddisfly (*Aoteapsyche*), and 'tolerant' orthoclad midges have characterised this site's communities on 22%, 63%, and 100% of past survey occasions respectively and were dominant in both spring and summer surveys.

3.2.5.4.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 85 (altitude) and 94 (distance) for this site. The historical site median (87) is 2 units higher than the altitude prediction and 8 units lower than the distance predictive value. The spring 2009 survey score (88 units) was within 6 units of both predictive values while the summer score (97 units) was significantly higher (Stark, 1998) than the predictive altitude value and 3 units above the predictive distance value. Of the 29 surveys to date at this site, 34% of MCI scores have been less than 85 units while 28% have been greater than 94 units.

3.2.5.4.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Waiwhakaiho River adjacent to Lake Rotomanu . The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 23 .



N = 29
Kendall tau = +0.134
p level = 0.308 [>FDR, p = 0.457]
N/S at p < 0.05

Figure 23 LOWESS trend plot of MCI data at the site adjacent to Lake Rotomanu

Overall, MCI scores have shown no statistically significant trend, despite a significant improvement during the first ten years of the programme (TRC, 2006b). Since 2004, there has been a steady decline in scores toward scores typically found in the first two years of the programme, followed by a further improvement, a similar trend found at the nearest upstream site (Constance St). The LOWESS-smoothed range of scores (15 units) is ecologically significant with more marked variability over the last six years. Smoothed MCI scores have indicated 'fair' generic stream 'health' (Table 1) throughout the period, where it currently remains. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, river health has improved from 'expected' to 'better than expected' between 1996 and

2005, before returning to 'expected' for two years and improving to 'better than expected' over the two most recent years.

3.2.5.5 Discussion

Seasonal MCI values atypically improved between spring and summer at all four sites by 5, 9, 1, and 9 units respectively in a downstream direction. Seasonal communities shared 45% of the 20 taxa common at the upper site, 54% of 28 taxa at the mid reach site, and 63% of 24 taxa at Constance Street, and 54% of 26 taxa at the furthest downstream site in the lower reaches.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 27 units in spring and 23 units in summer, over a river distance of 28.7 km. These seasonal falls in MCI scores equated to rates of decline of 0.9 unit/km (spring) and 0.8 unit/km (summer), compared with a predicted rate of 1.3 unit/km for the equivalent length and reach of a National Park-sourced river (Stark and Fowles, 2009). This was atypical of the trend of past summer seasonal increases in rates of decline.

Between the upper and mid-reach sites, the spring (1.1 units/km) and summer (0.7 unit/km) rates of decline were far lower than the predicted rate (2.6 units/km) for the equivalent river reach. For the mid-reach to lower reach sites, spring (0.8 unit/km) and summer (0.8 unit/km) rates of decline were slightly higher than the predicted rate of 0.6 unit/km.

Using the long-term median SEM MCI scores for each site (Appendix II), the rates of decline between upper and mid catchment and mid catchment and lower river sites have been about 1.7 and 1.1 units per km respectively with an overall average rate of decline of 1.4 MCI units/km over the river's length. Therefore rates of decline over the 2009-2010 period were lower in both spring and summer than typical of rates prior to 2009.

Community composition varied markedly through the length of the river surveyed. A total of 34 taxa was recorded in spring of which only eight taxa were present at all four sites. These included one 'highly sensitive', three 'moderately sensitive', and four 'tolerant' taxa with only the 'highly sensitive' ubiquitous mayfly, *Deleatidium* abundant at all four sites. Two of the 'tolerant' taxa were abundant at three sites (mid and lower reaches of the river). A similar total of 33 taxa was found along the river's length by the summer survey of which eight taxa also were present at all four sites. These were very similar to the eight widespread taxa in spring with the addition of one 'highly sensitive' (stonefly) taxon and one fewer 'tolerant' taxon. Only the one 'highly sensitive' mayfly and a 'moderately sensitive' beetle were abundant at all four sites. These dissimilarities in spatial community structure along the length of the Waiwhakaiho River were just as pronounced in spring as in summer.

3.2.6 Mangorei Stream

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. The results from the surveys performed in the 2009-2010 monitoring year are presented in Table 136 and Table 137, Appendix I.

3.2.6.1 SH3 site (MGE000970)

3.2.6.1.1 Taxa richness and MCI

Fourteen surveys have been undertaken at this lower reach site in the Mangorei Stream between November 2002 and March 2009. These results are summarised in Table 28, together with the results from the current period, and illustrated in Figure 24.

Table 28 Results of previous surveys performed in the Mangorei Stream at SH 3 prior to the spring 2009 survey, together with spring 2009 and summer 2010

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGE000970	14	22-33	29	86-113	105	30	102	25	102

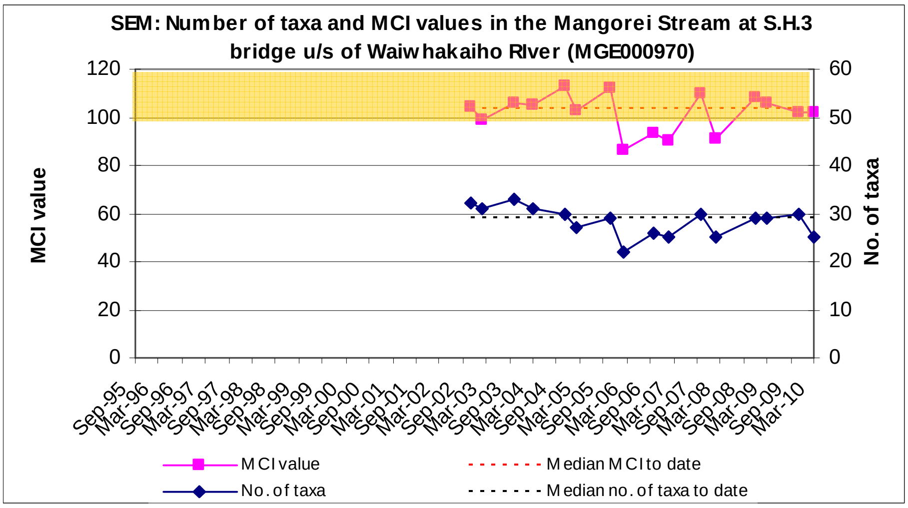


Figure 24 Numbers of taxa and MCI values in the Mangorei Stream at SH3

A moderate range of richnesses (22 to 33 taxa) has been found with a relatively high median richness of 29 taxa (more representative of typical richnesses in upper and middle reaches of ringplain streams and rivers. During the 2009-2010 period, spring (30 taxa) richness was very close to this median richness but 5 taxa more than found by the summer survey.

MCI values have had a relatively wide range (27 units) at this site, more typical of a site in the lower reaches of a ringplain stream. However, the median value (105 units) has been more typical of mid-reach sites elsewhere on the ringplain, and the spring, 2009 (102 units) and summer, 2010 (102 units) scores were both within 3 units of the historical median. These scores categorised this site as having 'good' health generically (Table 1) in both spring and summer and, in terms of predictive relationships (Table 2), 'better than expected' health for the lower reaches of a ringplain stream on both of these occasions. The historical median score (105 units) placed this site in the 'good' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.6.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 29.

Table 29 Characteristi taxa (abundant, very abundant, extremely abundant) recorded in the Mangorei Stream at SH3 between 2002 and March 2009 [14 surveys], and by the spring 2009 and summer 2010

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	2	14		
ANNELIDA	Oligochaeta	1	11	79	A	
MOLLUSCA	*Potamopyrgus*	4	3	21		
EPHEMEROPTERA	*Austroclima*	7	7	50	A	
	Coloburiscus	7	8	57		
	Deleatidium	8	9	64	A	
PLECOPTERA	*Zelandobius*	5	5	36		
	Zelandoperla	8	1	7		
COLEOPTERA	Elmidae	6	6	43	A	A
MEGALOPTERA	*Archichauliodes*	7	9	64	A	A
TRICHOPTERA	*Aoteapsyche*	4	13	93	VA	XA
	Costachorema	7	3	21		
	Hydrobiosis	5	7	50	A	
	Neurochorema	6	5	36		
	Confluens	5	3	21		
	Oxyethira	2	5	36		
	Pycnocentrodes	5	6	43		
DIPTERA	*Aphrophila*	5	11	79	VA	
	Maoridiamesa	3	4	29	A	
	Orthocladiinae	2	14	100	A	VA
	Tanytarsini	3	10	71		A
	Empididae	3	2	14		
	Muscidae	3	1	7		
	Austrosimulium	3	11	79		VA

Prior to the current 2009-2010 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. a balance of 'sensitive' and 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); nine 'moderately sensitive' taxa (mayflies (*Austroclima* and *Coloburiscus*), stonefly (*Zelandobius*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisflies (*Hydrobiosis* and *Neurochorema*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly

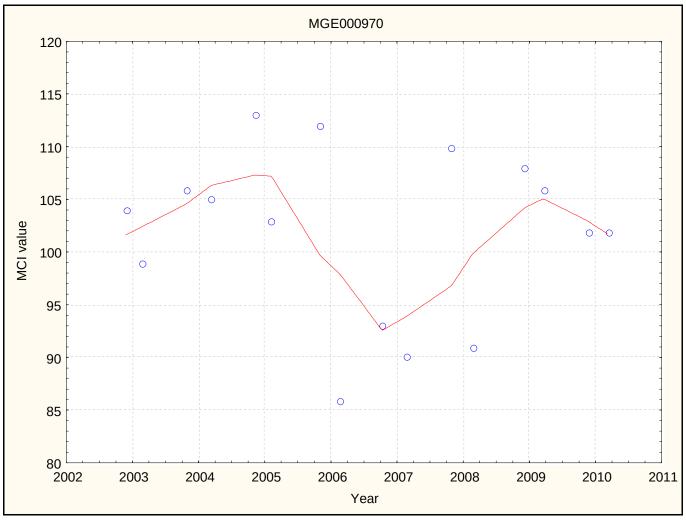
(*Aphrophila*)); and six 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), algal-piercing caddisfly (*Oxyethira*), midges (orthoclads and tanytarsids), and sandfly (*Austrosimulium*)). Nine of these predominant taxa were dominant in the spring, 2009 community together with one of the other historically characteristic taxa. The summer, 2010 community was characterised by fewer (four) of the taxa dominant in spring, together with an additional two 'tolerant' taxa, all of which previously had been characteristic of this site's communities (Table 29). This was reflected also in the 0.9 unit decrease in $SQMCI_s$ score recorded by the summer survey (Tables 136 and 137). All taxa recorded as very or extrememly abundant during spring and/or summer had characterised this site's communities on 79% to 100% of past surveys.

3.2.6.1.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 94 (altitude) and 101 (distance) for this site. The historical site median (105 units) is a significant (Stark 1998) 11 units higher than the altitude prediction and 4 units above the distance predictive value. The spring 2009 and summer 2010 survey scores (102 units) were higher by 8 units than the predictive value for altitude, while they were one unit higher than the predictive value for distance. Of the 16 surveys to date at this site, 25% of MCI scores have been less than 94 units while 69% have been greater than 101 units.

3.2.6.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the eight years (2002-2010) of SEM results collected to date from the site in the Mangorei Stream at SH3. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot trends in MCI data and Mann-Kendall test of significance are provided for this site.The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 25.



N = 16
Kendall tau = -0.101
p level = 0.586 [>FDR, p = 0.708]
N/S at $p < 0.05$

Figure 25 LOWESS trend plot of MCI data at the SH3 site

While MCI scores showed slight initial improvement over the first three years, followed by a steady decline, more recently there has been further improvement in scores towards those recorded earlier in the programme prior to a slight decine. The slight decline over the eight year period has not been a statistically significant trend during the relatively short period of monitoring at this site. The LOWESS-smoothed range of scores (14 units) represents some ecological significance in variability. During the period, these smoothed MCI scores have been consistently indicative of 'good' generic stream health (Table 1) until some deterioration to 'fair' health between 2006 and 2008.

In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, stream health has been 'better than expected' almost throughout the eight year period, bordering on 'well above expected' for a short period in 2004-2005, coincident with good riparian vegetation cover at this site.

3.2.6.2 Discussion

Seasonal MCI values atypically were identical between spring and summer at this lower reach (SH3) site despite the percentage composition of 'tolerant' taxa increasing slightly in the summer community. Seasonal communities at this site shared 20 common taxa (57% of the 35 taxa found at this site in 2009-2010), a moderate percentage of common taxa considering the identical MCI values for the two seasonal surveys. The increased abundances in certain individual 'tolerant' taxa in particular accounted for the decrease in $SQMCI_s$ value (0.9 unit) in summer under warmer, lower flow conditions.

3.2.7 Manganui River

The results found by the 2009-2010 surveys are presented in Table 138 and Table 139, Appendix I.

3.2.7.1 State Highway 3 site (MGN000195)

3.2.7.1.1 Taxa richness and MCI

Thirty surveys have been undertaken at this mid reach site in the Manganui River between September 1995 and March 2009. These results are summarised in Table 30 together with the results from the current period, and illustrated in Figure 26.

Table 30 Results of previous surveys performed in the Manganui River u/s of railway bridge (SH 3), prior to the spring 2009 survey, together with spring 2009 and summer 2010

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGN000195	30	12-26	21	113-143	126	17	129	23	115

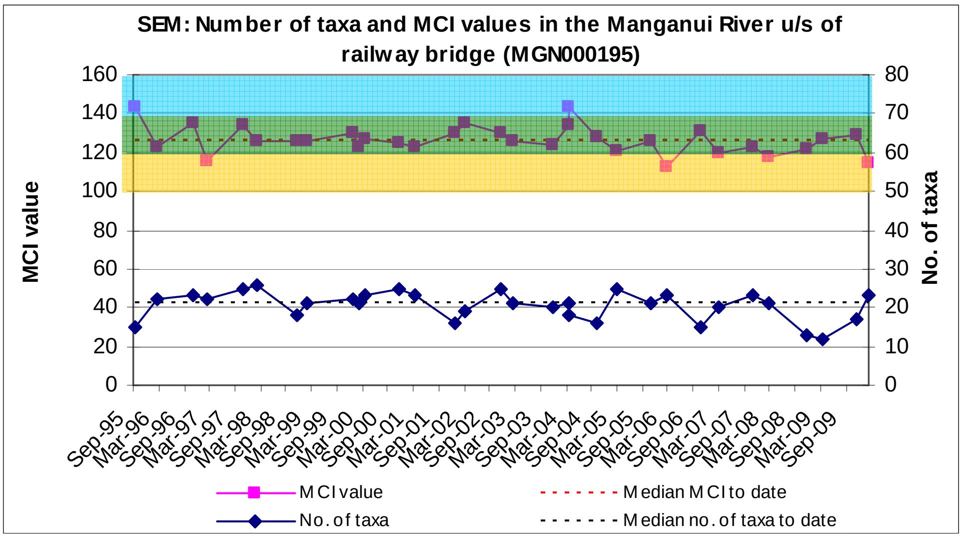


Figure 26 Numbers of taxa and MCI values in the Manganui River above the railway bridge (SH3)

A wide range of richnesses (12 to 26 taxa) has been found; with a median richness of 21 taxa (lower than typical richnesses in the mid-reaches of ringplain streams and rivers). During the 2009-2010 period richnesses increased between spring (17 taxa) and summer (23 taxa) and were within four taxa of this median richness.

MCI values have 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 (126 units) was higher than has been typical of mid-reach sites elsewhere on the ringplain. The spring, 2009 (129 units) and summer, 2010 (115 units) scores were 3 units higher and a significant 11 units lower than the historical median respectively. These scores categorised this site as having 'very good' health generically (Table 1) in spring and 'good' health in summer and, in terms of predictive relationships (Table 2), 'well above expected' health in spring and 'better than expected' health in summer for the mid reaches of a ringplain river. The historical median score (126 units) placed this site in the 'very good' and 'well above expected' categories for generic and predictive methods of assessment respectively.

3.2.7.1.2 Community composition

Characteristic macroinvertebrate taxa (abundant) in the communities at this site prior to the 2009-2010 period are listed in Table 31.

Table 31 Characteristic taxa (abundant, very abundant, extrememly abundant) recorded in the Manganui River at SH3 between 1995 and March 2009 [30 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
EPHEMEROPTERA	*Austroclima*	7	3	10		
	Coloburiscus	7	25	83	A	
	Deleatidium	8	29	97	VA	XA
	Nesameletus	9	20	67		VA
PLECOPTERA	*Acroperla*	5	1	3		
	Megaleptoperla	9	1	3		
	Zelandoperla	8	4	13	VA	
COLEOPTERA	Elmidae	6	27	90	A	VA
MEGALOPTERA	*Archichauliodes*	7	4	13		
TRICHOPTERA	*Aoteapsyche*	4	15	50		
	Hydrobiosis	5	0			A
	Beraeoptera	8	8	27		
	Pycnocentrodes	5	1	3		
DIPTERA	*Aphrophila*	5	20	67		
	Eriopterini	5	2	7		
	Austrosimulium	3	1	3		

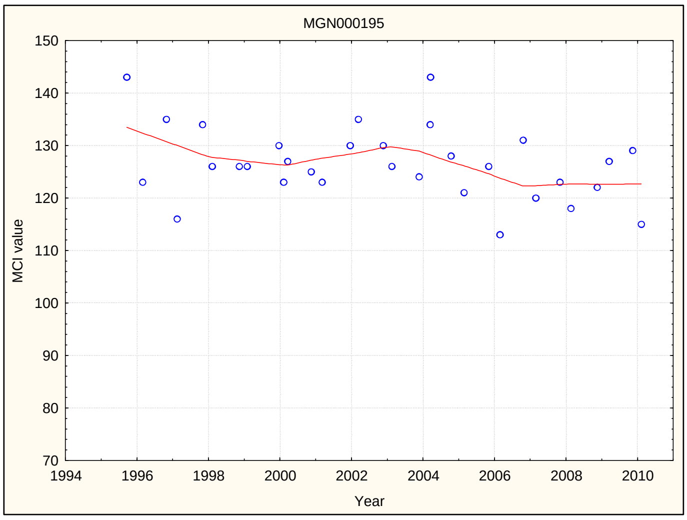
Prior to the current 2009-2010 period, 16 taxa have characterised the community at this site on occasions. These have comprised five 'highly sensitive', nine 'moderately sensitive', and two 'tolerant' taxa i.e. a higher proportion of 'sensitive' taxa than might be expected in the mid-reaches of a ringplain stream. Predominant taxa have included two 'highly sensitive' taxa (mayflies (*Deleatidium* and *Nesameletus*)); three 'moderately sensitive' taxa (elmid beetles, mayfly (*Coloburiscus*), and cranefly (*Aphrophila*)), and one 'tolerant' taxon (net-building caddisfly (*Aoteapsyche*)). Three of these predominant taxa were dominant in the spring, 2009 community together with one of the other historically characteristic taxa. The summer, 2010 community was characterised by two of the taxa dominant in spring, together with an additional one 'highly sensitive' taxon which previously had been characteristic of this site's communities (Table 31) and one 'moderately sensitive' taxon (caddisfly (*Hydrobiosis*)) which had not been recorded in abundance previously at this site. Despite some seasonal differences in dominant taxa composition, both season's $SQMCI_s$ values (7.5 and 7.6 units) were very similar (Tables 138 and 139). All four taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 13 % to 97% of past surveys.

3.2.7.1.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 118 (altitude) and 107 (distance) for this site. The historical site median (126 units) is 7 units higher than the altitude prediction and a significant (Stark, 1998) 19 units above the distance predictive value. The spring, 2009 survey score (129 units) was significantly higher by 11 to 22 units than both predictive values while the summer, 2010 score (115 units) was slightly lower than the predictive altitude value and higher than predictive distance value. Of the 32 surveys to date at this site, no MCI scores have been less than 107 units while 88% have been greater than 118 units.

3.2.7.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Manganui River at SH3. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 27.



N = 32
Kendall tau = -0.217
p level = 0.081 [>FDR, p = 0.192]
N/S at p < 0.05

Figure 27 LOWESS trend plot of MCI data at the SH3 site

Although a trend of slight overall decrease in MCI scores was identified, this was not statistically significant. The LOWESS-smoothed scores (range of 11 units) represented a marginal ecological significance in terms of variability. These MCI scores consistently indicated 'very good' generic river health (Table 1) over the fifteen year period.

In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain stream, river health has been 'well above expected' throughout the fifteen year period.

3.2.7.2 Bristol Road site (MGN000427)

3.2.7.2.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken at this lower reach site at Bristol Road in the Manganui river between October 1995 and February 2009. These results are summarised in Table 32 together with the results from the current period, and illustrated in Figure 28.

Table 32 Results of previous surveys performed in the Manganui River at Bristol Road prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGN000427	28	17-26	21	77-115	98	15	103	21	97

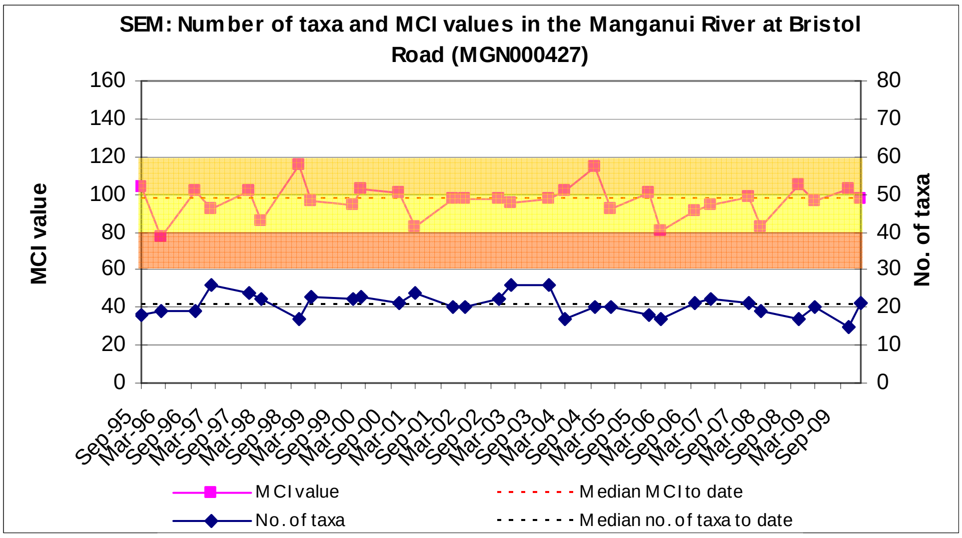


Figure 28 Numbers of taxa and MCI values in the Manganui River at Bristol Road

A moderate range of richnesses (17 to 26 taxa) has been found with a median richness of 21 taxa and representative of typical richnesses in ringplain streams and rivers in the lower reaches. During the 2009-2010 period, spring (15 taxa) and summer (21 taxa) richnesses were relatively different (by 6 taxa); slightly less than the minimum taxa number in spring but near the historical median richness in summer, despite widespread substrate periphyton cover on both occasions.

MCI scores have had a wide range (38 units) at this site, typical of sites in the lower reaches of ringplain streams elsewhere on the ringplain although this site was located at an atypical altitude of 140 m asl for a lower reach site more than 37 km downstream from the National Park. The median value (98 units) has been higher than typical of lower reach sites. The spring 2009 (103 units) and summer (97 units) scores were within 5 units of the historical median. These scores categorized this site as having 'good' (spring) and 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the lower reaches of a ringplain river. The historical median score (98 units) placed this site in the 'fair' category for generic and 'better than expected' category for predictive methods of assessment.

3.2.7.2.2 Community composition

Characteristic macroinvertebrate taxa abundant in the communities at this site prior to the 2009-2010 period are listed in Table 33.

Table 33 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Manganui River at Bristol Road between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	2	7		
ANNELIDA	Oligochaeta	1	16	57		
EPHEMEROPTERA	*Coloburiscus*	7	5	18		
	Deleatidium	8	12	43	XA	VA
COLEOPTERA	Elmidae	6	7	25		VA
MEGALOPTERA	*Archichauliodes*	7	2	7		
TRICHOPTERA	*Aoteapsyche*	4	20	71		VA
	Costachorema	7	3	11		A
	Hydrobiosis	5	8	29		A
	Neurochorema	6	2	7		
	Oxyethira	2	7	25		
DIPTERA	*Aphrophila*	5	12	43	VA	A
	Maoridiamesa	3	10	36	VA	A
	Orthocladiinae	2	28	100	XA	VA
	Tanytarsini	3	10	36		A
	Empididae	3	2	7		
	Muscidae	3	6	21		
	Austrosimulium	3	7	25		

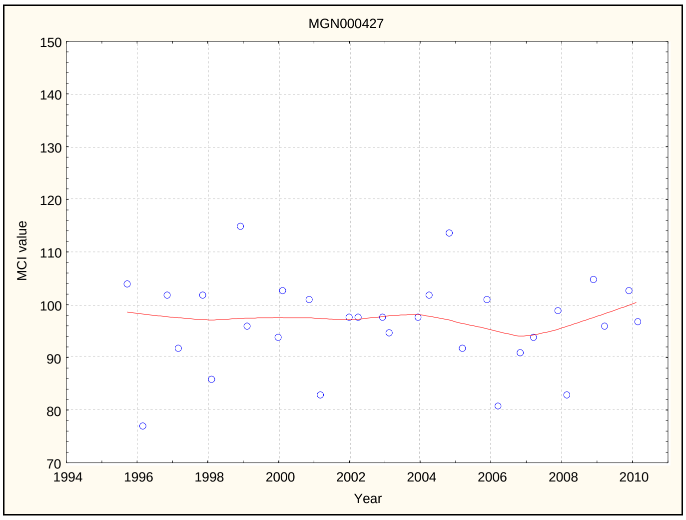
Prior to the current 2009-2010 period 18 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', seven 'moderately sensitive', and ten 'tolerant' taxa i.e. a majority of 'tolerant' taxa but slightly lower than might be expected in the lower reaches of a ringplain river due to this site's elevation above sea level. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); one 'moderately sensitive' taxon (cranefly (*Aphrophila*)); and five 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and midges (orthoclads, tanytarsids, and *Maoridiamesa*)). Four of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive', one 'moderately sensitive', and two 'tolerant' taxa, whereas four 'moderately sensitive' and four 'tolerant' taxa comprised the dominant taxa in the summer, 2010 community. Four of these nine taxa were dominant in both spring and summer communities (Table 33) which was reflected in the identical $SQMCI_s$ scores (4.9 units) recorded in both seasons (Tables 138 and 139). All taxa recorded as very or extremely abundant during spring and or summer had characterised this site's communities on 25% to 100% of past surveys.

3.2.7.2.3 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 beween MCI and site altitude and distance from the National park boundary (Stark and Fowles, 2009) predict MCI values of 99 (altitude) and 91 (distance) for this site. The historical site median (98 units) is very similar to the altitude predicton and 7 units higher than the predictive distance value, while the spring, 2009 survey score (103 units) was slightly higher than the altitude value but significantly higher than the distance predictive value. The summer score (97 units) was within 6 units of both the predictive values. Of the 30 surveys to date at this site, only 17% of MCI scores have been less than 91 units while 37% have been greater than 99 units.

3.2.7.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Manganui River at Bristol Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trendsin MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 29.



N = 30
Kendall tau = -0.028
p level = 0.828 [>FDR, p = 0.896]
N/S at $p < 0.05$

Figure 29 LOWESS trend plot at the Bristol Road site

The very slight overall negative trend in MCI scores was not statistically significant. Neither was the ecological variability in LOWESS-smoothed scores of 6 units. The smoothed MCI scores were indicative of 'fair' generic river health at this site throughout the fifteen year period. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain river, 'health' has remained 'better than expected' throughout the period.

3.2.7.3 Discussion

Seasonal MCI values typically decreased between spring and summer at the mid-reach (SH3) site by a significant 14 units (Stark, 1998) and by 6 units respectively at the lower reach site. The percentage composition of 'tolerant' taxa increased in the summer community by 25% at the mid reach site and 3% at the lower reach site. Seasonal communities at the mid-reach site (SH3) shared 17 common taxa (54% of the 26 taxa found at this site in 2009-2010) compared with 14 shared common taxa (71% of the 21 taxa found in 2009-2010) at the lower reach site (Bristol Road), a more pronounced seasonal change in community structure at the mid-reach site. The two sites shared 9 common taxa (39% of the 23 taxa) in spring and 16 common taxa (57% of 28 taxa) in summer, indicative of the dissimilarity in spatial community structures in summer and more particularly in spring.

MCI score typically fell in a downstream direction in both spring (by 26 units) and in summer (by 18 units), over a stream distance of 29.2 km downstream from the National Park boundary. These falls in MCI scores equated to rates of decline of 0.9 unit/km in spring decreasing to 0.6 unit/km in summer, compared with a predicted rate of 0.5 unit/km over the equivalent length and reach of a National Park-sourced stream (Stark and Fowles, 2009).

Using the long-term median SEM MCI scores for both sites (Appendix II), the rates of decline between mid catchment and lower river sites has been about 0.6 MCI unit/km over the surveyed length. Therefore rates of decline over the 2009 – 2010 period were higher in spring and similar in summer to rates prior to 2009.

3.2.8 Maketawa Stream

Two sites, previously 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 2009-2010 monitoring year are presented in Table 140 and 141 Appendix I.

3.2.8.1 Denby Road (MKW000200)

3.2.8.1.1 Taxa richness and MCI

Nineteen surveys have been undertaken at this upper reach site in the Maketawa Stream between March 1998 and March 2009. These results are summarised in Table 34 together with the results from the current period, and illustrated in Figure 30.

Table 34 Results of previous surveys performed in the Maketawa Stream at Denby Road prior to the spring 2009 survey, together with spring 2009 and summer 2010

Site code	SEM data (1995 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MKW000200	19	8-33	26	100-141	128	11	120	19	109

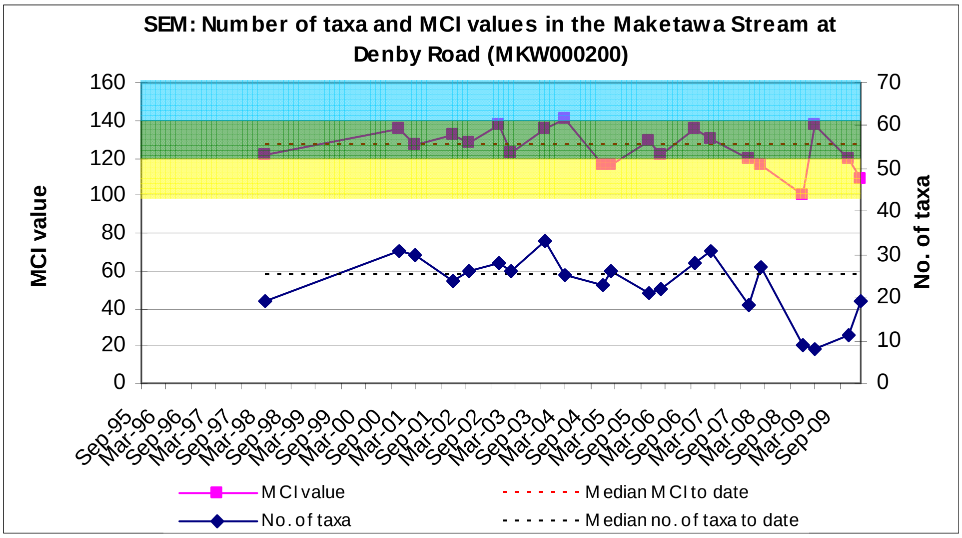


Figure 30 Number of taxa and MCI values in the Maketawa Stream at Denby Road

A very wide range of richnesses (8 to 33 taxa) has been found as a result of the impacts of previous headwater erosion events, with a median richness of 26 taxa (more representative of typical richnesses in the upper reaches of ringplain streams and rivers). During the 2009-2010 period, spring (11 taxa) and summer (19 taxa) richnesses were markedly different and much lower than this median richess.

MCI values have had a 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. The median value (128 units) however, has been typical of upper reach sites elsewhere on the ringplain, although the spring, 2009 (120 units) and summer, 2010 (109 units) scores were 8 and a significant 19 units below the historical median respectively.

These scores categorised this site as having 'very good' and 'good' generic health (Table 1) respectively in spring and summer and, in terms of predictive relationships (Table 2), 'worse than expected' and 'well below expected' health for the upper reaches of a ringplain stream on each of these occasions. The historical median score (128 units) placed this site in the 'very good' and 'worse than expected' categories for the generic and predictive methods of assessment respectively.

3.2.8.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 35.

Table 35 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Maketawa Stream at Denby Road between 1995 and March 2009 [19 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
EPHEMEROPTERA	*Austroclima*	7	1	5		
	Coloburiscus	7	11	58		
	Deleatidium	8	19	100	VA	XA
	Nesameletus	9	11	58		
PLECOPTERA	*Megaleptoperla*	9	10	53		
	Zelandoperla	8	14	74	A	A
COLEOPTERA	Elmidae	6	17	89		A
	Hydraenidae	8	3	16		
TRICHOPTERA	*Aoteapsyche*	4	10	53		
	Costachorema	7	4	21		A
	Hydrobiosis	5	1	5		
	Beraeoptera	8	10	53		
	Helicopsyche	10	8	42		
	Olinga	9	1	5		
	Pycnocentrodes	5	8	42		
DIPTERA	*Aphrophila*	5	10	53		
	Eriopterini	5	4	21		
	Maoridiamesa	3	4	21		
	Orthocladiinae	2	7	37		

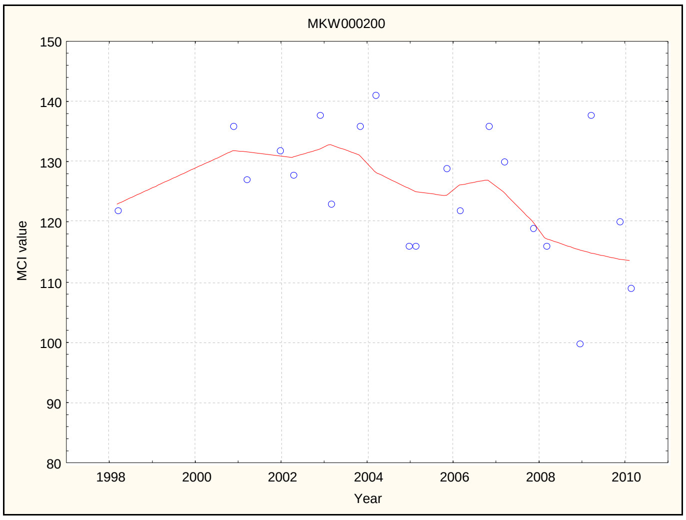
Prior to the current 2009-2010 period, 19 taxa have characterised the community at this site on occasions. These have comprised eight 'highly sensitive', eight 'moderately sensitive', and three 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the upper reaches of a ringplain stream. Predominant taxa have included six 'highly sensitive' taxa (mayflies (*Deleatidium*) on every occasion, and *Nesameletus*), stoneflies (*Megaleptoperla* and *Zelandoperla*), and cased caddisflies (*Beraeoptera* and *Helicopsyche*)); four 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)); and one 'tolerant' taxon (net-building caddisfly (*Aoteapsyche*)). Only two of these predominant taxa were dominant in the spring, 2009 community while the summer, 2010 community was characterised by both of the taxa dominant in spring, together with two additional 'moderately sensitive' taxa, all of which previously had been characteristic of this site's communities (Table 35). The similarity in the seasonally most dominant taxa composition was evident in the small difference (0.3 unit) in SQMCI$_s$ scores (Tables 140 and 141). The single taxon recorded as very or extrememly abundant during spring and/or summer (mayfly (*Deleatidium*)) had characterised this site's communities on every one of the past surveys.

3.2.8.1.3 Predicted stream 'health'

The Maketawa Stream site at Denby 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 123 (altitude) and 121 (distance) for this site. The historical site median (127 units) is 4 units higher than the altitude prediction and 6 units above the distance predictive value. The spring, 2009 survey score (120 units) was very similar to both predictive values while the summer, 2010 score (109 units) was significantly lower (by 12 to 14 units) than both predictive values. Of the 21 surveys to date at this site, 29% of MCI scores have been less than 121 units while 52% have been greater than 123 units.

3.2.8.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the ten years of SEM results collected to date from the site in the Maketawa Stream at Denby Road. The MCI has been chosen as the preferable indicator 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 31.



N = 21
Kendall tau = -0.262
p level = 0.096 [>FDR, p = 0.209]
N/S at $p < 0.05$

Figure 31 LOWESS trend plot of MCI data at the Denby Rd. site

No significant temporal trend in MCI scores has been found over the ten year monitoring period at this relatively pristine site where scores have tended to decrease gradually and particularly since the more recent headwater erosion events. The variability in LOWESS-smoothed scores (range of 19 units) represented moderate ecological significance during the period accentuated by the impact of headwater erosion events during 2008.

Overall, smoothed scores remained indicative of 'very good' generic stream health (Table 1) for the majority of the period, dropping to 'good' health since 2008 where it has remained.

In terms of predictive relationships (Table 2) for a site in the upper reaches of a ringplain stream, stream health has been 'worse than expected' almost throughout the ten year period, but falling to 'well below expected' since the headwater erosion events of 2008.

3.2.8.2 Tarata Road site (MKW000300)

3.2.8.2.1 Taxa richness and MCI

Eighteen surveys have been undertaken at this mid-reach site at Tarata Road in the Maketawa Stream between March 1998 and March 2009. These results are summarised in Table 36, together with the results from the current period, and illustrated in Figure 32.

Table 36 Results of previous surveys performed in the Maketawa Stream at Tarata Road prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MKW000300	18	12-31	24	90-115	99	18	106	21	105

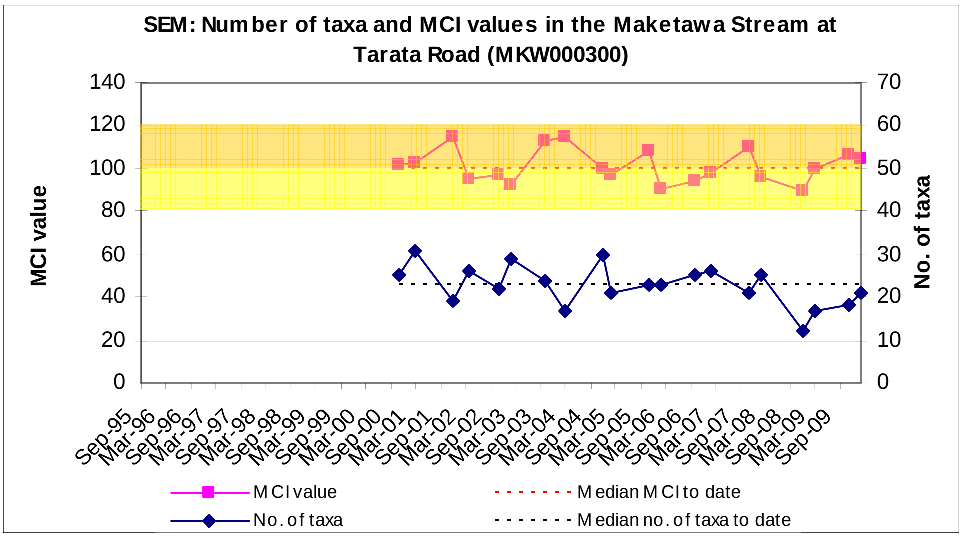


Figure 32 Number of taxa and MCI values in the Maketawa Stream at Tarata Road

A wide range of richnesses (12 to 31 taxa) has been found; wider than might be expected, with a median richness of 24 taxa and more representative of typical richnesses in the mid-reaches of ringplain streams and rivers. During the 2009-2010 period, spring (18 taxa) and summer (21 taxa) richnesses were relatively similar, but lower than the median taxa number on both occasions coincident with marked substrate periphyton cover in spring and summer.

MCI scores have had a relatively wide range (25 units) at this site, more typical of sites in the lower reaches of ringplain streams. The median value (99 units) has been relatively typical of mid-reach sites elsewhere on the ringplain. The spring, 2009 (106 units) and summer, 2010 (105 units) scores were within the range typical for such a site and slightly higher than the historical median by 7 and 6 units respectively. These scores categorized this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the mid-reaches of a ringplain stream. The historical median score (99 units) placed this site in the 'fair' category for generic and 'expected' category for predictive methods of assessment.

3.2.8.2.2 Community composition

Characteristic macroinvertebrate taxa abundant in the communities at this site prior to the 2009-2010 period are listed in Table 37.

Table 37 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Maketawa Stream at Tarata Road between 1995 and February 2009 [18 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	7	39		
EPHEMEROPTERA	*Austroclima*	7	3	17		
	Coloburiscus	7	8	44	A	
	Deleatidium	8	9	50	XA	VA
PLECOPTERA	*Acroperla*	5	1	6		
COLEOPTERA	Elmidae	6	4	22		
MEGALOPTERA	*Archichauliodes*	7	2	11		
TRICHOPTERA	*Aoteapsyche*	4	10	56		A
	Costachorema	7	7	39		A
	Hydrobiosis	5	7	39		
	Neurochorema	6	3	17		
	Beraeoptera	8	2	11		
	Confluens	5	2	11		
	Oxyethira	2	4	22		
	Pycnocentrodes	5	1	6		
DIPTERA	*Aphrophila*	5	15	83	A	A
	Maoridiamesa	3	13	72		A
	Orthocladiinae	2	18	100	A	A
	Tanytarsini	3	7	39		
	Empididae	3	1	6		
	Muscidae	3	4	22		
	Austrosimulium	3	2	11		

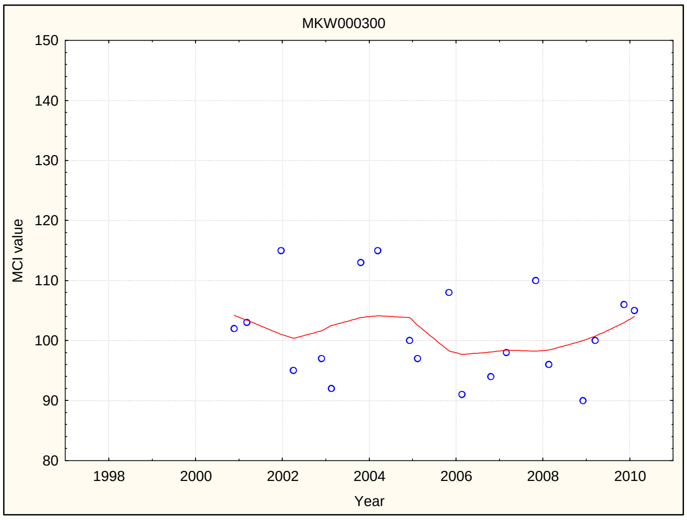
Prior to the current 2009-2010 period 22 taxa have characterised the community at this site on occasions. These have comprised two 'highly sensitive', eleven 'moderately sensitive', and nine 'tolerant' taxa i.e. a relatively even balance between 'sensitive' and 'tolerant' taxa as might be expected in the mid-reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); four 'moderately sensitive' taxa (mayfly (*Coloburiscus*), free-living caddisflies (*Hydrobiosis* and *Costachorema*), and cranefly (*Aphrophila*)); and five 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and midges (orthoclads, tanytarsids and *Maoridiamesa*)). Four of the historically characteristic taxa were dominant in the spring 2009 community. These comprised one 'highly sensitive', two 'moderately sensitive', and one 'tolerant' taxa, whereas one 'highly sensitive', two 'moderately sensitive', and three 'tolerant' taxa comprised the dominant taxa in the summer community. Three of these 7 taxa were dominant in both spring and summer communities (Table 37). An increase in the proportional dominance of 'tolerant' taxa, and reduction in abundance of the one 'highly sensitive' taxon, was reflected in the 1.5 unit decrease in summer $SQMCI_S$ score (Tables 140 and 141). The single taxon recorded as very or extremely abundant during spring and summer had characterised this site's communities on 50% of past surveys.

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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 100 (altitude) and 101 (distance) for this site. The historical site median (100 units) is equivalent to the altitude prediction and only one unit lower than the predictive distance value, while the spring, 2009 survey score (106 units) was slightly higher than these predictive values. The summer, 2010 score (105 units) was also slightly higher than these predictive values. Of the 21 surveys to date at this site, 45% of MCI scores have been less than 100 units while 45% have been greater than 101 units.

3.2.8.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006), has been performed on the ten years of SEM results collected to date from the site, in the Maketawa Stream at Tarata Road. The MCI has been chosen as the preferable indicator 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend pot of MCI data is presented in Figure 33.



N = 20
Kendall tau = - 0.090
p level = 0.578 [>FDR, p = 0.708]
N/S at $p < 0.05$

Figure 33 LOWESS trend plot at the Tarata Road site

The slightly decreasing trend in MCI scores found over the ten year monitoring period has not been statistically significant. Ecological variability in LOWESS-smoothed scores (which ranged over 7 units) was not significant with scores indicative of 'good' generic stream health (Table 1) trending downward to 'fair' stream health, between 2005 and 2009 before returning to 'good' health more recently. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain stream, stream health has been 'better than expected' for the majority of the period.

3.2.8.3 Discussion

Seasonal MCI values typically deteriorated between spring and summer at the upper reach (Denby Road) site whereas an atypical decrease (one unit) was found at the mid-reach site. Seasonal communities at the upper reach site shared 10 common taxa (53% of the 19 taxa found at this site in 2009-2010) compared with 17 shared common taxa (77% of the 22 taxa found in 2009-2010) at the mid-reaches site (Tarata Road), an atypically more pronounced seasonal change in community structure at the upper of the two sites. The two sites shared 10 common taxa (53% of the 19 taxa) in spring and 15 common taxa (60% of 25 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and summer, although atypically less so in summer.

MCI score typically fell in a downstream direction in both spring (by 14 units) and atypically, less markedly in summer (by 4 units), over a stream distance of 15.1 km downstream from the Denby Road site. These falls in MCI scores equated to rates of decline of 1.1 units/km in spring decreasing to 0.3 unit/km in summer, compared with a predicted rate of 1.5 units/km over the equivalent length and reach of a National Park-sourced stream (Stark and Fowles, 2009).

Using the long-term median SEM MCI scores for both sites (Appendix II), the rate of overall decline has been 1.8 MCI units/km over the river's length. Therefore rates of decline over the 2009 – 2010 period were lower in spring and in summer to rates prior to 2010.

3.2.9 Waitara River

The results found by the 2009-2010 surveys are presented in Table 142 and Table 143, Appendix I.

3.2.9.1 Mamaku Road site (WTR000850)

3.2.9.1.1 Taxa richness and MCI

Twenty eight surveys have been undertaken at this lower reach site in the Waitara River between November 1995 and February 2009. These results are summarised in Table 38, together with the results from the current period, and illustrated in Figure 34.

Table 38 Results of previous surveys performed in the Waitara River at Mamaku Road, prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WTR000850	28	9-32	21	64-101	85	20	92	20	93

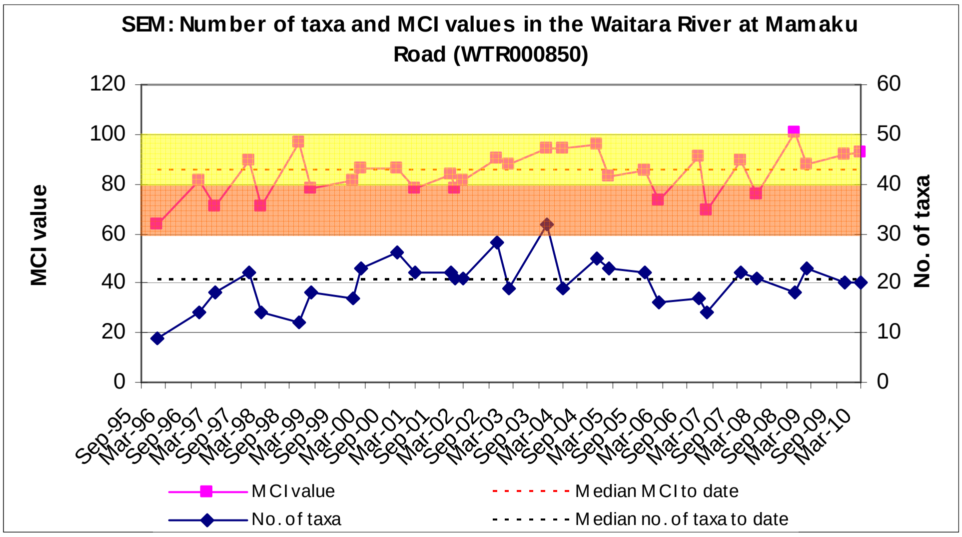


Figure 34 Numbers of taxa and MCI values in the Waitara River upstream of Methanex at Mamaku Road

A very wide range of richnesses (9 to 32 taxa) has been found with a moderate median richness of 21 taxa (more representative of typical richnesses in the lower reaches of streams and rivers). During the 2009-2010 period, spring and summer richnesses (20 taxa) were very close to this median richness.

MCI values have had a wide range (37 units) at this site, more typical of a site in the lower reaches of streams and rivers. However, the median value (85 units) has been more typical of lower reach sites elsewhere. The spring, 2009 (92 units) and summer, 2010 (93 units) scores were 7 to 8 units higher than the historical median. These scores categorised this site as having 'fair' health generically (Table 1) in both spring and summer and, in terms of predictive relationships (Table 2), 'better than expected' health for the lower reaches of a river with some ringplain catchment component on both of these occasions. The historical median score (85 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.9.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 39.

Table 39 Characterisic taxa (abundant, very abundant, extremely abundant) recorded in the Waitara River at Mamaku Road between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	2	7		
ANNELIDA	Oligochaeta	1	18	64	A	A
	Branchyura	1	1	4		
	Polychaeta	3	2	7		
MOLLUSCA	*Latia*	5	10	36		
	Potamopyrgus	4	16	57		A
CRUSTACEA	Tanaidacea	3	1	4		
	Paratya	3	13	46		
EPHEMEROPTERA	*Deleatidium*	8	6	21	A	
COLEOPTERA	Elmidae	6	0			A
TRICHOPTERA	*Aoteapsyche*	4	16	57	A	VA
	Oxyethira	2	10	36		
	Pycnocentrodes	5	4	14		
DIPTERA	*Aphrophila*	5	10	36	A	
	Maoridiamesa	3	2	7	A	
	Orthocladiinae	2	18	64	VA	A
	Tanytarsini	3	8	29		VA
	Austrosimulium	3	1	4		

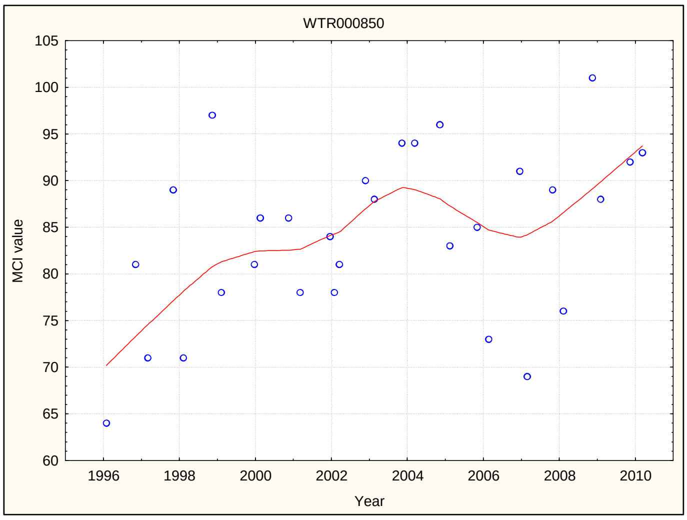
Prior to the current 2009-2010 period, 17 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', three 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included two 'moderately sensitive' taxa (luminescent freshwater limpet (*Latia*) and cranefly (*Aphrophila*)); and six 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), freshwater shrimp (*Paratya)*, net-building caddisfly (*Aoteapsyche*), algal-piercing caddisfly (*Oxyethira*), and orthoclad midges). Four of these predominant taxa were dominant in the spring, 2009 community together with two of the other historically characteristic taxa. The summer, 2010 community was characterised by fewer of the taxa dominant in spring, together with an additional three taxa; all but one ('sensitive' elmid beetles) of which previously had been characteristic of this site's communities (Table 39). Despite several seasonal differences in characteristic taxa, the similarity in numbers of 'tolerant' taxa in spring and summer surveys was reflected in the minimal difference (0.2 unit) in $SQMCI_s$ scores (Tables 142 and 143). All taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 29% to 64 % of the past surveys.

3.2.9.2.1 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 eastern hill country and ringplain sub-catchments. A relationship for ringplain streams and rivers developed between MCI and altitude (Stark and Fowles, 2009) predicts a MCI value of 86 units for this site. The historical site median (86 units) was equivalent with this altitude prediction while the spring, 2009 (92 units) and summer, 2010 (93 units) scores were higher than this predictive value by 6 and 7 units respectively. These two 2009-2010 surveys' scores were also significantly (Stark, 1998) 17 and 18 units higher than the median MCI (75 units) found from 202 previous surveys of 'control' sites below 25 m asl in hill country catchment streams and rivers (TRC, 1999 (updated, 2009)). Of the 30 surveys to date at this river site, 17% of MCI scores have been less than 75 units while 43% have been greater than 86 units.

3.2.9.3 Temporal trends in 1995 to 2010 data

Non-paramentric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years (1995-2010) of SEM results collected to date from the site in the Waitara River at Mamaku Road. The MCI has been chosen as the preferable indicator 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 35.



N = 30
Kendall tau = +0.293
p level = 0.023 [>FDR, p = 0.070]
Significant at p< 0.05
Not significant after FDR application

Figure 35 LOWESS trend plot of MCI data for the Mamaku Road site

Despite a statistically significant improvement in MCI scores over the first ten years of monitoring (p< 0.05 after FDR), a more recent trend of falling scores has resulted in an overall positive trend for the fifteen year period which has not been significant statistically. This may be consistent with the earlier assessment that linked improvement with climatic factors in this large, predominantly eastern hill country catchment. The range of LOWESS-smoothed scores (23 units) has been ecologically significant. During the period, these MCI scores have been indicative of a general improvement from 'poor' to 'fair' generic river health (Table 1).

In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain river (recognising the partial ringplain component of this catchment), river health has been within the 'expected' category almost throughout the fifteen year period, improving to 'above expected' over the recent survey period.

3.2.9.4 Discussion

Seasonal MCI values atypically were very similar between spring and summer at this lower reach site with the percentage community compositions of 'tolerant' taxa very similar (within 5%) on both occasions. However, seasonal communities at this site shared only 13 common taxa (48% of the 27 taxa found at this site in 2009-2010), a relatively low percentage of common taxa considering the near identical MCI values for the seasonal surveys. A decrease in the abundances of two individual 'tolerant' taxa in particular, accounted for the small increase in $SQMCI_s$ value (0.2 unit) in summer, coincident with a small reduction in filamentous algal substrate cover.

3.2.10 Mangati Stream

The results found by the 2009-2010 surveys are presented in Table 144 and Table 145, Appendix I.

3.2.10.1 Site downstream of railbrige (MGT000488)

3.2.10.1.1 Taxa richness and MCI

Twenty-nine surveys have been undertaken at this site in the upper reaches of this small coastal stream draining an industrial catchment between October 1995 and March 2009. These are summarised in Table 40, together with the results from the current period, and illustrated in Figure 36.

Table 40 Results of previous surveys performed in the Mangati Stream at the site downstream of the railbridge prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Dec 2009		Mar 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGT000488	29	9-29	17	56-85	77	11	69	16	83

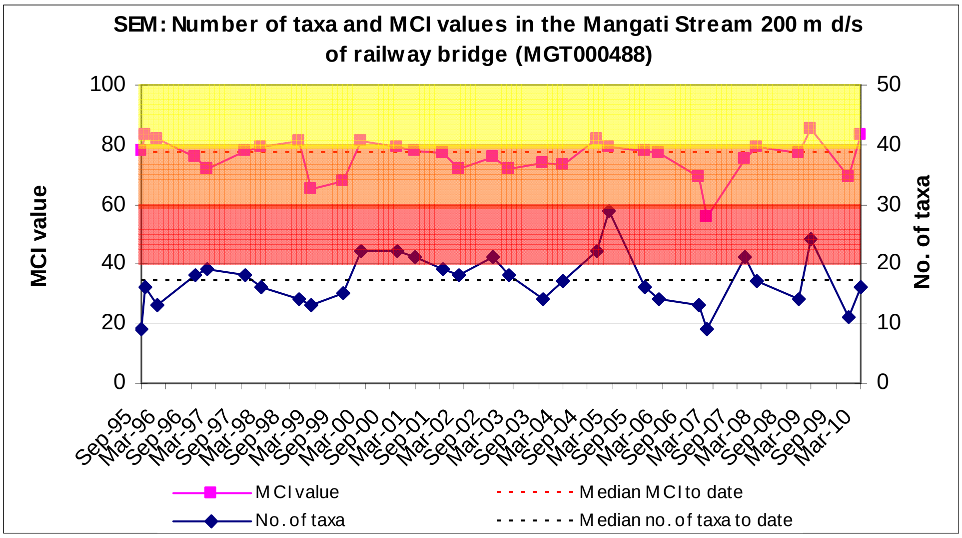


Figure 36 Numbers of taxa and MCI values in the Mangati Stream downstream of the railbridge

A very wide range of richnesses (9 to 29 taxa) has been found; with a median richness of 17 taxa (more representative of typical richnesses in upper, swampy reaches of small coastal streams (TRC, 1999 (updated 2009)). During the 2009-2010 period, spring (11 taxa) and summer (16 taxa) richnesses were dissimilar and lower or close to this median richness.

MCI values have had a relatively wide range (29 units) at this site, relatively typical of a site in a small coastal stream. The median value (77 units) also has been typical of such streams elsewhere on the ringplain, and the spring, 2009 (69 units) and summer, 2010 (83 units) scores, although significantly different, were within 8 units of the historical median. These scores were also 3 units (spring) and a significant 17 units (summer) higher than the median score previously recorded by 37 surveys at 'control' sites in similar lowland coastal streams at altitudes between 25 m and 50 m asl (TRC, 1999 (updated, 2009)). These scores categorised this site as having 'poor' health generically (Table 1) in spring and 'fair' health in summer. The historical median score (77 units) placed this site in the 'poor' category for the generic method of assessment.

3.2.10.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 41.

Table 41 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Mangati Stream at the site downstream of the railbridge between 1995 and March 2009 [29 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
PLATYHELMINTHES	*Cura*	3	5	17		
NEMERTEA	Nemertea	3	3	10		
ANNELIDA	Oligochaeta	1	27	93	A	A
	Lumbricidae	5	1	3		
MOLLUSCA	*Physa*	3	4	14		
	Potamopyrgus	4	29	100	VA	VA
	Sphaeriidae	3	1	3		
CRUSTACEA	Ostracoda	1	9	31		
	Paracalliope	5	28	97		
	Phreatogammarus	5	1	3		
EPHEMEROPTERA	*Austroclima*	7	11	38		
	Zephlebia group	7	1	3		
HEMIPTERA	*Microvelia*	3	1	3		
TRICHOPTERA	*Hydrobiosis*	5	1	3		
	Polyplectropus	6	1	3		
	Oxyethira	2	3	10		
DIPTERA	Orthocladiinae	2	13	45	A	
	Austrosimulium	3	18	62		A

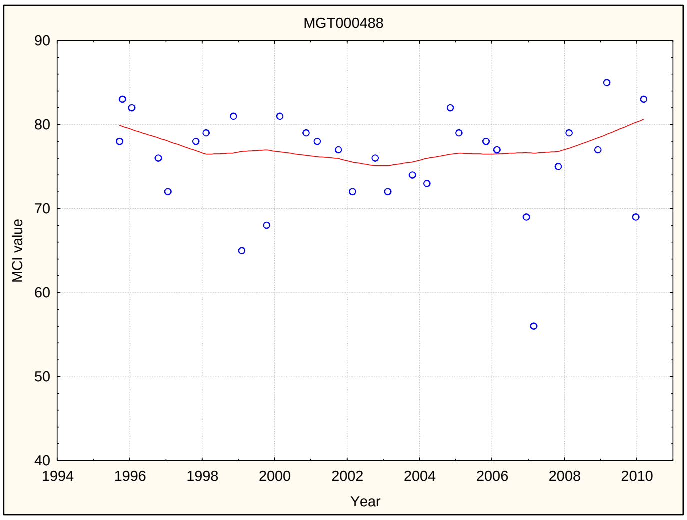
Prior to the current 2009-2010 period, 18 taxa have characterised the community at this site on occasions. These have comprised seven 'moderately sensitive' and eleven 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa as would be expected in the swampier upper reach of a softer bottom, macrophyte dominated, small coastal stream. Predominant taxa have included two 'moderately sensitive' taxa (amphipod (*Paracalliope*) and mayfly (*Austroclima*)); and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), ostracod seed shrimps, sandfly (*Austrosimulium*), and orthoclad midges)). Only three of these predominant taxa were dominant in the spring, 2009 community and again in the summer, 2010 community which was characterised by two of the taxa dominant in spring, together with an additional single 'tolerant' taxon, all of which had been characteristic of this site's communities (Table 41). The similarity in seasonal dominant taxa was reflected in the very small difference (0.2 unit) between spring and summer $SQMCI_s$ scores (Tables 144 and 145). The four taxa recorded as abundant or very abundant during spring and summer had characterised this site's communities on 45% to 100% of past surveys.

3.2.10.1.3Predicted stream 'health'

The Mangati Stream site downstream of the railbridge is in the upper, swampier reaches of a small coastal stream at an altitude of 30 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009) however, are not applicable in this type of small coastal stream.

3.2.10.1.4Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Mangati Stream at the site downstream of the railbridge. The MCI has been chosen as the preferable indicator 'stream/river health/ for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 37.



N = 31
Kendall tau = - 0.084
p level = 0.508 [>FDR, p = 0.662]
N/S at p < 0.05

Figure 37 LOWESS trend plot of MCI data at the site downstream of the railbridge

There was a small negative overall trend identified in the MCI scores, which had no statistical significance, with a small recent improvement in scores. This site's scores have had a LOWESS-smoothed range of only 5 units indicative of no ecological significance over the period.

Overall, smoothed scores remained indicative of 'poor' generic stream health (Table 1) throughout the period, trending toward 'fair' health more recently. It also must be recognised that trends in the health of this 'soft-bottomed' lowland stream may be assessed more appropriately in future by application of the more recently established soft-bottomed MCI (SBMCI).

3.2.10.2 Te Rima Place, Bell Block (MGT000520)

3.2.10.2.1Taxa richness and MCI

Twenty-nine surveys have been undertaken at this lower reach site at SH45 in the Mangati Stream between October 1995 and March 2009. These results are summarised in Table 42, together with the results from the current period, and illustrated in Figure 38.

Table 42 Results of previous surveys performed in the Mangati Stream at Te Rima Place, Bell Block prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Mar 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGT000520	29	3-22	10	44-76	63	7	63	12	70

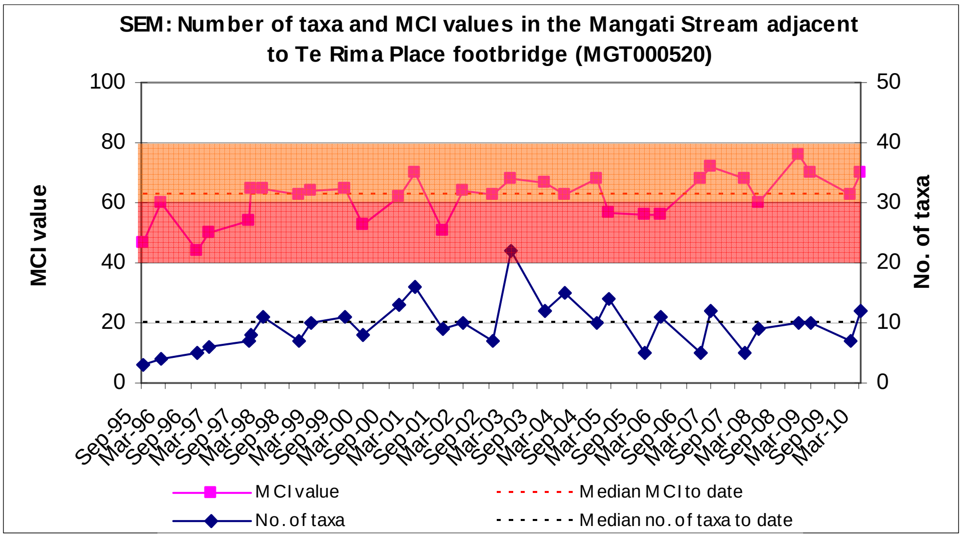


Figure 38 Numbers of taxa and MCI values in the Mangati Stream at Te Rima Place footbridge

A wide range of richness (3 to 22 taxa) has been found; wider than might be expected with a median richness of 10 taxa but not atypical of richnesses in the lower reaches of small coastal streams. During the 2009-2010 period, spring (7 taxa) and summer (12 taxa) richnesses were dissimilar but within 3 taxa of the median taxa number. The lower richness in spring was coincident with prior scouring of the substrate.

MCI scores have had a relatively wide range (32 units) at this site, more typical of sites in the lower reaches of small coastal streams. The median value (63 units) also has been relatively typical of lower reach sites in coastal streams with the spring, 2009 (63 units) and summer, 2010 (70 units) scores within the range typical for such a site and within 7 units of the historical median. These scores were a significant 12 units (spring), and 5 units (summer) lower than the median score found by 200 surveys at 'control sites' in similar lowland coastal streams at altitudes of less than 25 m asl (TRC, 1999 (updated, 2009)). These scores categorised this site as having 'poor' (spring and summer) health generically (Table 1). The historical median score (63 units) placed this site in the 'poor' category for the generic method of assessment.

3.2.10.2.2 Community composition

Characteristic macroinvertebrate taxa abundant in the communities at this site prior to the 2009-2010 period are listed in Table 43.

Table 43 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Mangati Stream at Te Rima Place, Bell Block between 1995 and March 2009 [29 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	2	7		
ANNELIDA	Oligochaeta	1	29	100	XA	XA
MOLLUSCA	*Potamopyrgus*	4	11	38	XA	XA
CRUSTACEA	Ostracoda	1	1	3		
TRICHOPTERA	*Oxyethira*	2	1	3		
	Triplectides	5	2	7		VA
DIPTERA	Orthocladiinae	2	23	79		A
	Empididae	3	2	7		
	Austrosimulium	3	5	17		

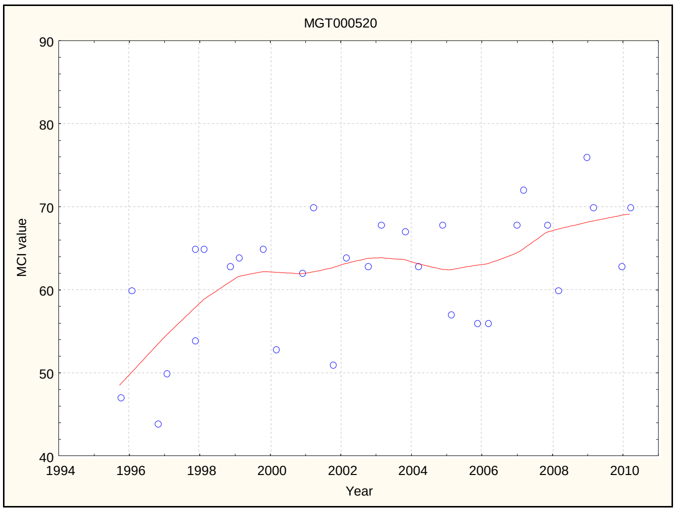
Prior to the current 2009-2010 period a small number of taxa (9) has characterised the community at this site on occasions. These have comprised one 'moderately sensitive' and eight 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a small coastal ringplain stream. Predominant taxa have included no 'moderately sensitive' taxa but three 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges). Only two of the historically characteristic taxa were dominant in the spring, 2009 community. These were both 'tolerant' taxa whereas these and an additional 'moderately sensitive' and 'tolerant' taxon comprised the dominant taxa in the summer community and their extreme abundances on both occasions were reflected in the minimal difference (0.2 unit) in seasonal $SQMCI_s$ scores (Tables 144 and 145). Two of these four taxa were dominant in both spring and summer communities (Table 43). The two taxa recorded as extremely abundant during spring and summer had characterised this site's communities on 38% to 100% of past surveys.

3.2.10.2.3 Predicted stream 'health'

The Mangati Stream at Te Rima Place, Bell Block is in the lower, more stony-bottomed reaches of a small coastal stream at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009) however, are not applicable in this type of small coastal stream.

3.2.10.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site, in the Mangati Stream at the Te Rima Place, Bell Block site. The MCI has been chosen as the preferable indicator 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 39.



N = 31
Kendall tau = + 0.392
p level = 0.0020 [>FDR, p = 0.011]
Significant at p < 0.05 and after FDR application

Figure 39 LOWESS trend plot at the Te Rima Place, Bell

A positive temporal trend in MCI scores, statistically significant (p<0.05) prior to and after FDR analysis, indicated some further improvement coincident with better control and treatment of industrial point source discharges in the upper and mid-catchment and wetland installation in mid catchment. The LOWESS-smoothed range of scores (21 units) was ecologically significant with MCI scores indicative of a shift from 'very poor' to 'poor' generic stream health (Table 1) during the period. This trend of improvement in stream 'health' at this site is much more pronounced than the trend at the site 1.5 km upstream, indicating that activities in the catchment between these two sites have had a significant influence.

3.2.10.3 Discussion

Seasonal MCI values atypically improved between spring and summer at both sites with an increase in the percentage composition of 'moderately sensitive' taxa in the summer communities. Seasonal communities at the upper reach site shared 7 common taxa (35% of the 20 taxa found at this site in 2009-2010) compared with 6 shared common taxa (46% of the 13 taxa found in 2009-2010) at the lower reaches site, a more pronounced seasonal change in community structure at the upper reach site. The two sites shared only 4 common taxa (29% of the 14 taxa) in spring and 8 common taxa (40% of 20 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and summer.

MCI score typically fell in a downstream direction in both spring (by 6 units) and more markedly in summer (by 13 units), over a stream distance of 1.5 km equating to rates of decline much higher than predicted over the equivalent length in the lower reaches of a National Park-sourced stream (Stark and Fowles, 2009).

3.2.11 Waimoku Stream

The results found by the 2009-2010 surveys are presented in Table 146 and Table 147, Appendix I.

3.2.11.1 Lucy's Gully (WMK000100)

3.2.11.1.1Taxa richness and MCI

Twenty surveys have been undertaken at this upper reach site in the Waimoku Stream (in the Kaitake Ranges) between December 1999 and March 2009. These results are summarised in Table 44, together with the results from the current period, and illustrated in Figure 40.

Table 44 Results of previous surveys performed in the Waimoku Stream at Lucy's Gully prior to the spring 2009 survey, together with spring 2009 and summer 2010

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WMK000100	20	25-37	31	121-137	132	29	130	32	125

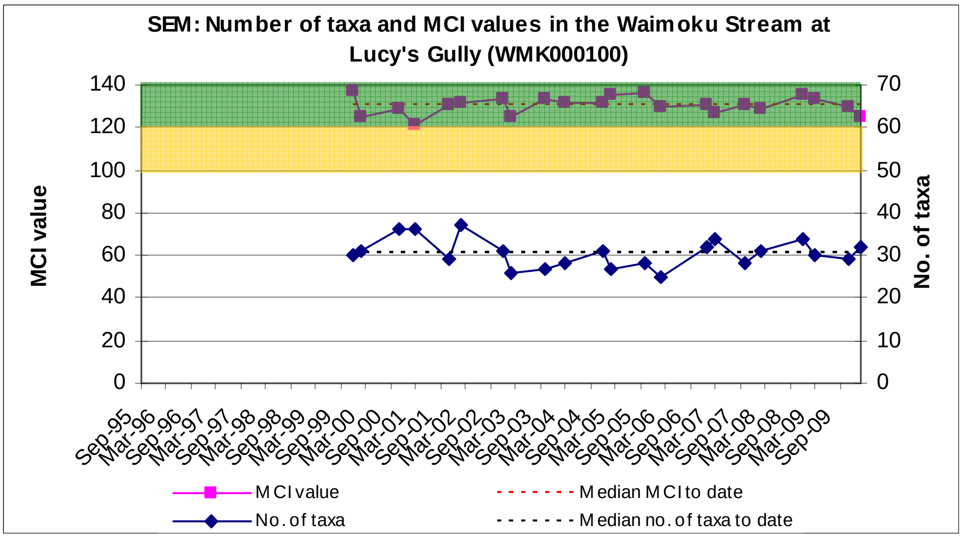


Figure 40 Numbers of taxa and MCI values in the Waimoki Stream at Lucy's Gully

A moderate range of richnesses (25 to 37 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 2009-2010 period, spring (29 taxa) and summer (32 taxa) richnesses were similar and very close to this median richness.

MCI values also have had a moderate range (16 units) at this site, relatively typical of a site in the upper reaches of a ringplain stream. The median value (132 units) also has been typical of upper reach sites elsewhere on the ringplain, and the spring, 2009 (130 units) and summer, 2010 (125 units) scores were 2 and 7 units below the historical median respectively. These scores categorised this site as having 'very good' health generically (Table 1) in both spring and summer and, in terms of predictive relationships (Table 2), 'expected' and 'worse than expected' health for the upper reaches of a ringplain stream on spring and summer occasions respectively.

The historical median score (132 units) placed this site in the 'very good' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.11.1.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 45.

Table 45 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waimoku Stream at Lucy's Gully between 1999 and March 2009 [20 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	3	15		
MOLLUSCA	*Potamopyrgus*	4	5	25		
EPHEMEROPTERA	*Austroclima*	7	14	70	VA	A
	Coloburiscus	7	20	100	VA	VA
	Deleatidium	8	18	90	A	A
	Ichthybotus	8	1	5		
	Zephlebia group	7	17	85	A	VA
PLECOPTERA	*Austroperla*	9	15	75	A	
	Stenoperla	10	2	10		
	Zelandobius	5	1	5		
COLEOPTERA	Elmidae	6	1	5		
	Ptilodactylidae	8	3	15	A	
MEGALOPTERA	*Archichauliodes*	7	2	10		
TRICHOPTERA	*Hydrobiosella*	9	6	30	A	
	Orthopsyche	9	20	100	VA	A
DIPTERA	Orthocladiinae	2	17	85	A	
	Polypedilum	3	2	10	A	A

Prior to the current 2009-2010 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 Kaitaki Ranges. Predominant taxa have included four 'highly sensitive' taxa (mayfly (*Deleatidium*), stonefly (*Austroperla*), and free-living caddisflies (*Orthopsyche* and *Hydrobiosella*)); three 'moderately sensitive' taxa (mayflies (*Austroclima, Coloburiscus,* and *Zephlebia* group)); and one 'tolerant' taxon (orthoclad midges). Eight of these predominant taxa were dominant in the spring, 2009 community together with two of the other historically characteristic taxa. The summer, 2010 community was characterised by six of the taxa dominant in spring, all but one of which previously had been predominantly characteristic of this site's communities (Table 45). All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 70% to 100% of past surveys.

3.2.11.1.3Predicted stream 'health'

The Waimoki Stream site at Lucy's Gully is within the Kaitaka Ranges of the National Park boundary at an altitude of 160 m asl.

Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 101 (altitude) and 132 (distance) for this site. The historical site median (132 units) is significantly 31 units higher than the altitude prediction and equal with the distance predictive value. The spring, 2009 survey score (130 units) was very similar to the distance predictive value as was the summer score (125 units). Of the 22 surveys to date at this site, no MCI scores have been less than 101 units while 32% have been greater than 132 units.

3.2.11.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the eleven years of SEM results collected to date from the site in the Waimoku Stream at Lucy's Gully. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 41.

N = 22
Kendall tau = +0
p level = 1.00 [>FDR, p = 1.00]
N/S at $p < 0.05$ level

Figure 41 LOWESS trend plot of MCI data at the Lucy's Gully site

No significant temporal trend in MCI scores has been found over the eleven year period at this pristine site within the National Park. The LOWESS-smoothed range of scores (5 units) has no ecological significance and these MCI scores have continuously indicated 'very good' generic stream health (Table 1).

In terms of predictive relationships (Table 2) for a site in the upper reaches of a ringplain stream, smoothed LOWESS MCI scores have indicated stream health as 'expected' almost throughout the eleven year period.

3.2.11.2 Oakura Beach (WMK000298)

3.2.11.2.1 Taxa richness and MCI

Twenty surveys have been undertaken at this lower reach site at Oakura Beach in the Waimoku Stream between December 1999 and March 2009. These results are summarised in Table 46, together with the results from the current period, and illustrated in Figure 42.

Table 46 Results of previous surveys performed in the Waimoku Stream at Oakura Beach prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WMK000298	20	10-26	20	75-101	88	22	95	16	93

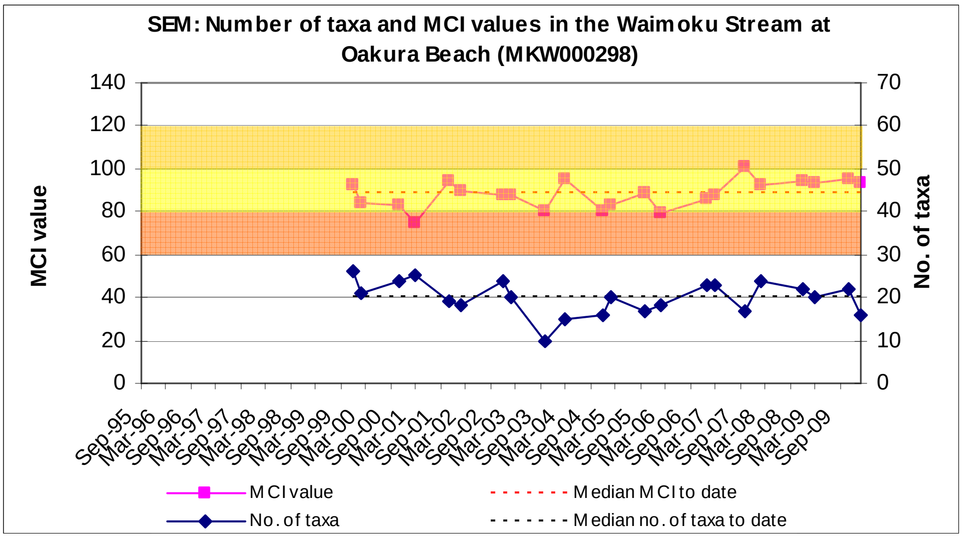


Figure 42 Numbers of taxa and MCI values in the Waimoku Stream at Oakura Beach

A wide range of richness (10 to 26 taxa) has been found; wider than might be expected, with a median richness of 20 taxa which was more representative of typical richnesses in ringpain streams and rivers in the lower reaches. During the 2009-2010 period, spring (22 taxa) and summer (16 taxa) richnesses were quite different (by 6 taxa); similar to the median taxa number in spring but lower than the median richness in summer, coincident with more widespread substrate periphyton cover on the latter occasion.

MCI scores have had a relatively wide range (26 units) at this site and typical of 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 however, but the spring, 2009 (95 units) and summer, 2010 (93 units) scores were within the range typical for such a site and higher than the historical median by 7 and 5 units respectively. These scores categorised this site as having 'fair' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the lower reaches of a ringplain stream. The historical median score (88 units) placed this site in the 'fair' category for generic and 'expected' category for predictive methods of assessment.

3.2.11.2.2Commnity composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 47.

Table 47 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waimoku Stream at Oakura Beach between 1999 and March 2009 [20 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	3	15		
ANNELIDA	Oligochaeta	1	17	85	A	A
MOLLUSCA	*Potamopyrgus*	4	14	70	VA	A
	Sphaeriidae	3	1	5		
CRUSTACEA	Ostracoda	1	1	5		
	Paratya	3	1	5		
EPHEMEROPTERA	*Austroclima*	7	5	25		
	Coloburiscus	7	1	5		
TRICHOPTERA	*Hydrobiosis*	5	3	15		
	Oxyethira	2	3	15		
	Triplectides	5	4	20		
DIPTERA	*Aphrophila*	5	5	25		
	Maoridiamesa	3	1	5		
	Orthocladiinae	2	19	95	A	VA
	Polypedilum	3	1	5		A
	Empididae	3	1	5		
	Austrosimulium	3	9	45		A

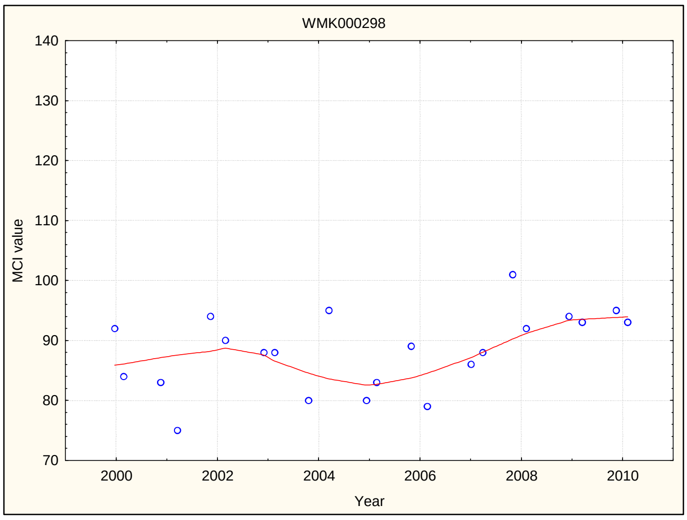
Prior to the current 2009-2010 period 17 taxa have characterised the community at this site on occasions. These have comprised no 'highly sensitive', five 'moderately sensitive', and twelve 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'moderately sensitive' taxa, but four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), sandfly (*Austrosimulium*), and orthoclad midges). Only three of the historically characteristic taxa were dominant in the spring 2009, community. These were comprised only of 'tolerant' taxa, while an additional two 'tolerant' taxa comprised the dominant taxa in the summer community. Three of these 13 taxa were dominant in both spring and summer communities (Table 47). The two taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 70% to 95% of past surveys.

3.2.11.2.3 Predicted stream 'health'

The Waimoki Stream at Oakura Beach is only 4 km downstream of the National Park boundary at an altitude of 1 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 85 (altitude) and 116 (distance) for this site. The historical site median (88 units) is slightly higher (by 3 units) than the altitude prediction but 28 units lower than the predictive distance value, while the spring, 2009 survey score (95 units) and summer, 2010 score (93 units) were higher than the predictive altitude value by 10 and 8 units respectively. Of the 22 surveys to date at this site 32% of MCI scores have been less than 85 units while no scores have been greater than 116 units.

3.2.11.2.4 Temporal trends in 1995 to 2010 data

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the eleven years of SEM results collected to date from the site, in the Waimoku Stream at Oakura Beach. The MCI has been chosen as the preferable indicator 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 43.



N = 22
Kendall tau = +0.283
p level = 0.066 [>FDR, p = 0.170]
N/S at p < 0.05 level

Figure 43 LOWESS trend plot of MCI data at the Oakura Beach site

A positive temporal trend in MCI scores has been recorded over the eleven year monitoring period but this trend has not been statistically significant. The range of LOWESS-smoothed scores (11 units) has been of marginal ecological significance over this period.

These smoothed MCI scores have consistently indicated 'fair' generic stream health (Table 1) at this site in the lower reaches of the stream. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, the stream health has improved from 'expected' to 'better than expected' where it has remained since 2008.

3.2.11.3 Discussion

Seasonal MCI values remained relatively similar between spring and summer as is typical at the upper reach Lucy's Gully site whereas a more typical, but small, seasonal decrease (of 2 units) was found at the lower reach site where the percentage composition of 'tolerant' taxa increased by 9% in the summer community. Seasonal communities at the upper reach site shared 22 common taxa (56% of the 39 taxa found in 2009-2010) compared with 13 shared common taxa (52% of the 25 taxa found in 2009-2010) at the lower reach site (Oakura Beach), a slightly more pronounced seasonal change in community structure at the lower reach site. The two sites shared 14 common taxa (38% of the 37 taxa) in spring and 12 common taxa (33% of 36 taxa) in summer, indicative of the dissimilarity in spatial community structures in spring and to a slightly greater extent in summer.

MCI score typically fell in a downstream direction in both spring (by 35 units) and slightly less markedly in summer (by 32 units), over a stream distance of 4.0 km downstream from the National Park boundary. These falls in MCI scores equated to rates of decline of 8.8 units/km in spring decreasing to 8.0 units/km in summer. These were far higher than the predicted rate of 2.0 units/km over the equivalent length and reach of a National Park-sourced stream (Stark and Fowles, 2009), due to the short distance between the Kaitake Ranges area of the National Park and the western ringplain coastline.

Using the long-term median SEM MCI scores for both sites (Appendix II), the rate of overall decline has been 10.5 MCI units/km over the surveyed length. Therefore rates of decline over the 2009 – 2010 period were lower in spring and similar in summer to rates prior to 2010.

3.2.12 Waiau Stream

The results found by the 2009-2010 surveys are presented in Table 148 and Table 149, Appendix I for this small lowland stream.

3.2.12.1 Inland North site (WAI000100)

3.2.12.1.1 Taxa richness and MCI

Twenty-one surveys have been undertaken in this mid-reach site in the Waiau Stream between February 1998 and February 2009. These results are summarised in Table 48, together with the results from the current period, and illustrated in Figure 44.

Table 48 Results of previous surveys performed in Waiau Stream at Inland North Road, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1998 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WAI000100	21	17-30	21	80-98	88	20	91	24	87

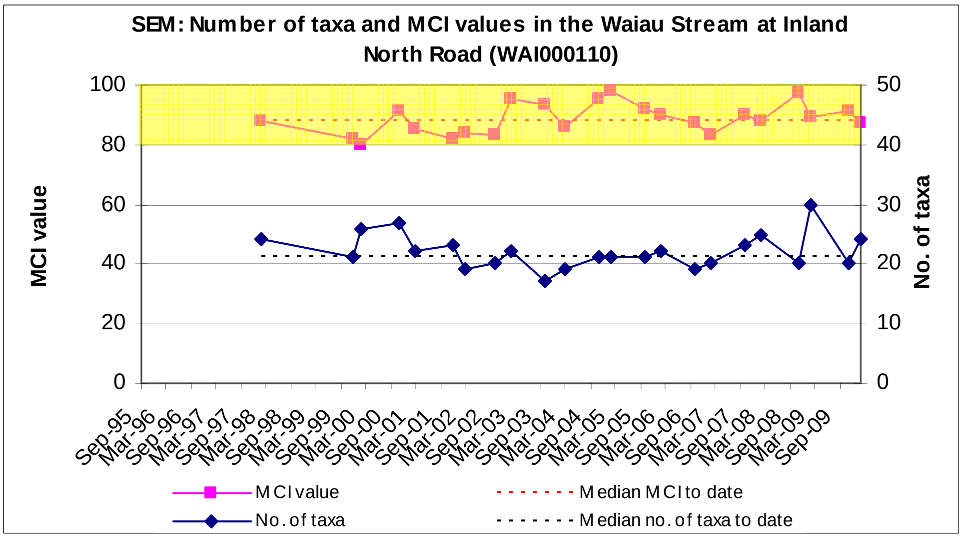


Figure 44 Numbers of taxa and MCI values in the Waiau Stream at the Inland North Road site

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 streams where a median richness of 20 taxa has been recorded from 82 previous surveys of 'control' sites at similar altitudes (TRC, 1999 (updated, 2009)). During the 2009-2010 period, spring (20 taxa) and summer (24 taxa) richnesses were relatively similar and within three taxa of this median richness.

MCI values have had a moderate range (18 units) at this site. The median value (89 units) has been typical of lower reach sites elsewhere on the ringplain however, and the spring, 2009 (91 units) and summer, 2010 (87 units) scores were typical for such a site. These were within 3 units of the historical median on both occasions.
These scores categorised this site as having 'fair' (spring and summer) health generically (Table 1) and were significantly higher (Stark, 1998) than the median MCI score (76 units) recorded by 82 previous surveys of 'control' sites between 50

and 79 m asl in small, lowland streams in Taranaki (TRC, 1999 (updated, 2009)). The historical median score (88 units) placed this site in the 'fair' category for the generic method of assessment and was also significantly higher than the median score recorded at similar sites elsewhere.

3.2.12.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 49.

Table 49 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiau Stream at Inland North Road between 1998 and February 2009 [21 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	3	14		
ANNELIDA	Oligochaeta	1	13	62		A
MOLLUSCA	*Latia*	5	8	38	A	
	Potamopyrgus	4	21	100	VA	XA
CRUSTACEA	*Paracalliope*	5	14	67		A
EPHEMEROPTERA	*Austroclima*	7	19	90		VA
COLEOPTERA	Elmidae	6	21	100	VA	VA
TRICHOPTERA	*Aoteapsyche*	4	19	90	A	A
	Hydrobiosis	5	8	38		
	Hudsonema	6	2	10		
	Oxyethira	2	7	33		
	Pycnocentria	7	9	43		
	Pycnocentrodes	5	17	81	A	
DIPTERA	*Aphrophila*	5	11	52	A	
	Maoridiamesa	3	1	5		
	Orthocladiinae	2	17	81	A	VA
	Polypedilum	3	1	5		
	Tanytarsini	3	1	5		
	Austrosimulium	3	5	24		
ACARINA	Acarina	5	1	5		

Prior to the current 2009-2010 period, 20 taxa had characterised the community at this site on occasions. These have comprised ten '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 lower reaches of a ringplain stream.

Predominant taxa have included eight 'moderately sensitive' taxa (luminescent limpet (*Latia*), amphipod (*Paracalliope*), mayfly (*Austroclima*), elmid beetles, free-living caddisfly (*Hydrobiosis*), stony-cased caddisflies (*Pycnocentrodes* and *Pycnocentria*), and cranefly (*Aphrophila*)), and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisly (*Aoteapsyche*), algal-piercing caddisfly (*Oxyethira*), and orthoclad midges).

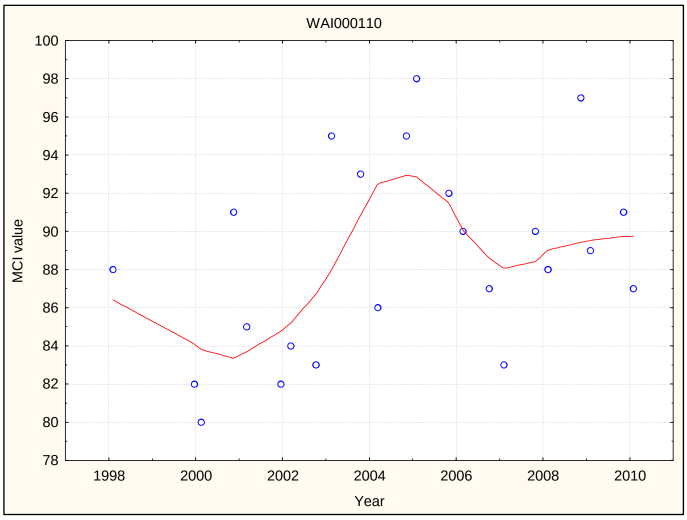
Seven of the historically characteristic taxa were dominant in the spring, 2009 community and comprised seven of the predominant taxa (above). The summer, 2010 community was characterised by four of the taxa dominant in spring, together with an additional two 'moderately sensitive' and one 'tolerant' (midge) taxa, all of which previously had been predominantly characterisctic of this site's communities (Table 49). The identical balance between these dominant 'sensitive' and 'tolerant' taxa proportions in the spring and summer surveys was reflected in the relatively small difference in $SQMCI_s$ scores (0.4 unit) between seasons (Tables 148 and 149). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 81% to 100% of past surveys.

3.2.12.1.3Predicted stream 'health'

The Waiau Stream rises as seepage beyond the ringplain and the site at Inland North Road is in the mid reaches at an altitude of 50 m asl. Relationships for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), therefore are not applicable in this type of small lowland stream.

3.2.12.1.4Temporal trends in 1995 to 2010 data

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twelve years of SEM results collected to date from the site, in the Waiau Stream at Inland North Road. The MCI has been chosen as the preferable indicator 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 45.



N = 23
Kendall tau = +0.241
p level = 0.108 [>FDR, p = 0.216]
N/S at $p < 0.05$ level

Figure 45 LOWESS trend plot of MCI data at the Inland North Road site

No significant temporal trend in MCI scores has been found over the twelve year monitoring term at this site, with the initial trend of increasing scores having been followed by a small decline in scores to slightly above those recorded early in the programme before a more upward trend. The range of LOWESS-smoothed scores (10 units) has not quite been of ecological significance. LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) throughout the period.

3.2.12.2 Discussion

Seasonal MCI values typically decreased between spring and summer (but only by 4 units) at this mid reach site of a lowland stream where the percentage composition of 'tolerant' taxa increased by 6% in the summer community when periphyton mats and filamentous algal substrate cover was more pronounced under much warmer water temperature conditions. Seasonal communities at this site shared 18 common taxa (69% of the 26 taxa found at this site in 2009-2010)), a relatively high percentage of common taxa thereby contributing to the relative similarity in MCI values.

3.2.13 Punehu Stream

The results of the spring (2009) and summer (2009-2010) surveys are summarised in Table 150 and Table 151, Appendix I.

3.2.13.1 Wiremu Road site (PNH000200)

3.2.13.1.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken in the Punehu Stream between 1995 and February 2009 at this open, upper mid-reach site in farmland, 4 km downstream of the National Park These results are summarised in Table 50 together with the results from the current period, and illustrated in Figure 46.

Table 50 Results of previous surveys performed in the Punehu Stream at Wiremu Road prior to the spring 2009 survey, together with spring 2009 and summer 2010

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000200	28	19-31	27	104-133	121	25	128	23	125

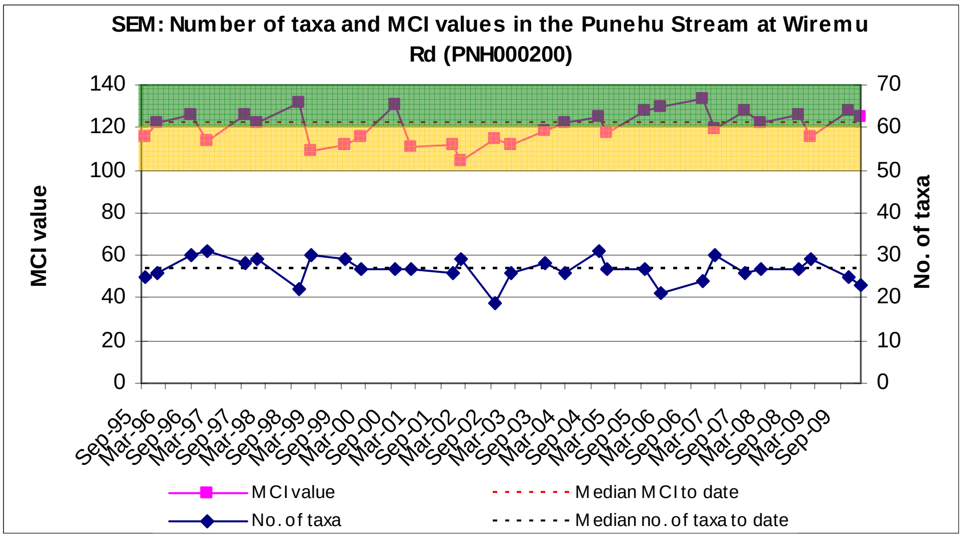


Figure 46 Numbers of taxa and MCI values in the Punehu Stream at Wiremu Road

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). During the 2009-2010 period, spring (25 taxa) and summer (23 taxa) richnesses were similar and slightly lower than this median richness.

MCI values have had a moderate range (29 units) at this site, typical of a site in the mid reaches of a ringplain stream in more open farmland. The median value (121 units) has been typical of mid reach sites elsewhere on the ringplain. The spring, 2009 (128 units) and summer, 2010 (125 units) scores were 7 and 4 units above the historical median respectively. These scores categorised this site as having 'very good' generic health (Table 1) in spring and summer and, in terms of predictive relationships (Table 2), well above 'expected' health for the mid reaches of a ringplain stream on both of these occasions. The historical median score (121 units) placed this site in the 'very good' and 'well above expected' categories for the generic and predictive methods of assessment respectively.

3.2.13.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site perior to the 2009-2010 period are listed in Table 51.

Table 51 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Punehu Stream at Wiremu Road between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	4	14		
MOLLUSCA	*Potamopyrgus*	4	1	4		
EPHEMEROPTERA	*Austroclima*	7	4	14		
	Coloburiscus	7	26	93	VA	A
	Deleatidium	8	28	100	XA	XA
	Nesameletus	9	24	86	VA	VA
PLECOPTERA	*Acroperla*	5	2	7		
	Megaleptoperla	9	5	18		
	Zelandoperla	8	18	64	VA	A
COLEOPTERA	Elmidae	6	28	100	VA	XA
	Hydraenidae	8	5	18		
MEGALOPTERA	*Archichauliodes*	7	2	7		
TRICHOPTERA	*Aoteapsyche*	4	20	71		A
	Costachorema	7	17	61	A	
	Hydrobiosis	5	9	32		
	Beraeoptera	8	10	36	VA	VA
	Helicopsyche	10	3	11		
	Olinga	9	2	7		
	Oxyethira	2	1	4		
	Pycnocentrodes	5	17	61	VA	XA
DIPTERA	*Aphrophila*	5	5	18		
	Eriopterini	5	5	18	A	A
	Maoridiamesa	3	12	43	VA	
	Orthocladiinae	2	16	57		
	Empididae	3	1	4		

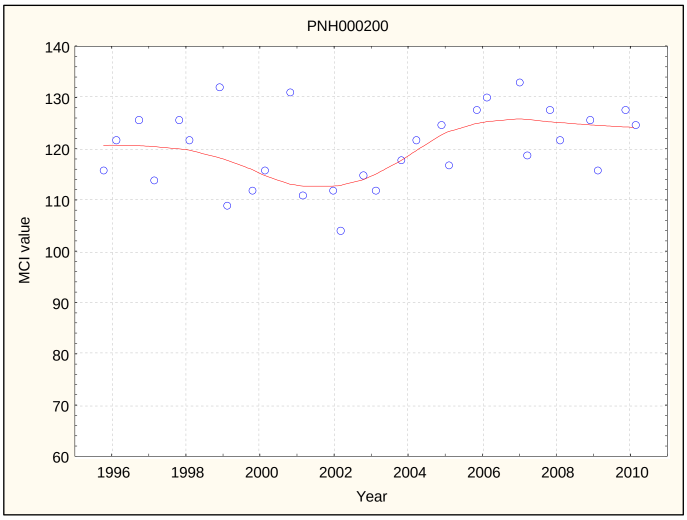
Prior to the current 2009-2010 period, 25 taxa have characterised the community at this site on occasions. These have comprised eight 'highly sensitive', ten 'moderately sensitive', and seven 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the mid reaches of a ringplain stream. Predominant taxa have included four 'highly sensitive' taxa (mayflies (*Deleatidium*) on every occasion, and *Nesameletus*), stonefly (*Zelandoperla*), and cased caddisfly (*Beraeoptera*)) ; five 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles (on very occasion), stony-cased caddisfly (*Pycnocentrodes*), and free-living caddisflies (*Costachorema* and *Hydrobiosis*)), and three 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*) and midges (orthoclads and *Maoridiamesa*)). Nine of these predominant taxa were dominant in the spring, 2009 community together with one other 'moderately sensitive' taxon while the summer, 2010 community was characterized by all but two of the taxa dominant in spring, together with one additional, 'moderately sensitive' taxon, all of which previously had been characteristic of this site's communities (Table 51). The similarity in the seasonally most dominant taxa composition was evident in the small 0.5 unit $SQMCI_s$ difference in scores (Tables 150 and 151). All taxa recorded as very or extremely abundant during spring and/or summer had characterized this site's communities on 36% to 100% of the past surveys.

3.2.13.1.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 112 (altitude) and 115 (distance) for this site. The historical site median (121 units) is 9 units higher than the altitude prediction and 6 units above the distance predictive value. The spring, 2009 survey score (128 units) was significantly (Stark, 1998) higher than both predictive values while the summer, 2010 score (125 units) was significantly higher (by 13 units) than the altitude predictive value and 10 units above the distance predictive value. Of the 30 surveys to date at this site, only 10% of MCI scores have been less than 112 units while 73% have been greater than 115 units.

3.2.13.1.4 Temporal trends 1995 to 2010

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site, in the Punehu Stream at Wiremu Road. The MCI has been chosen as the preferable indicator 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 47.



N = 30
Kendall tau = +0.212
p level = 0.101 [>FDR, p = 0.209]
N/S at p < 0.05 level

Figure 47 LOWESS trend plot of MCI data at the Wiremu Road site

Although a steady increase in MCI scores had been apparent between 2002 and 2007, the overall slightly positive trend in scores over the period has not been statistically significant. The range of LOWESS-smoothed scores (12 units) has some ecological significance, particularly since 2002 (coincident with localised riparian fencing and planting of the true left-bank of the stream). Overall, smoothed MCI scores were indicative of 'good' generic stream health (Table 1) until 2001 improving to 'very good' health in more recent years.

In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain stream, stream health has been 'better than expected' for the period to 2004 improving to 'well above expected' since 2009.

3.2.13.2 SH 45 site (PNH000900)

3.2.13.2.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken at this lower reach site at SH 45 in the Punehu Stream between 1995 and February 2009. These results are summarised in Table 52, together with the results from the current period, and illustrated in Figure 48.

Table 52 Results of previous surveys performed in the Punehu Stream at SH 45 prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000900	28	10-25	21	70-99	85	21	105	21	92

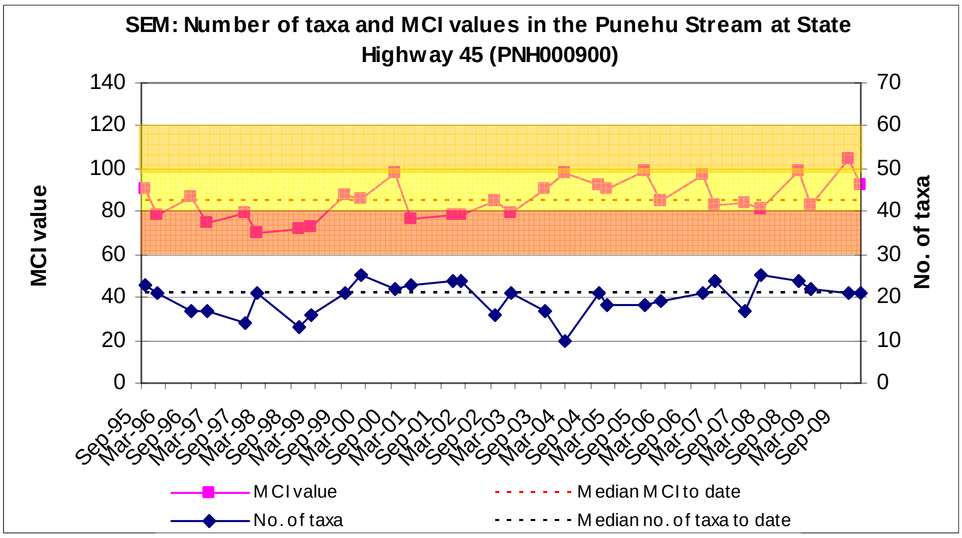


Figure 48 Numbers of taxa and MCI values in the Punehu Stream at SH 45

A moderate range of richnesses (10 to 25 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 2009-2010 period, spring (21 taxa) and summer (21 taxa) richnesses were identical and equal with the median taxa number on both occasions coincident with similar substrate periphyton cover in both spring and summer although water temperatures were higher at the time of the summer survey.

MCI scores have had a relatively wide range (29 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (85 units) has been relatively typical of lower reach sites elsewhere on the ringplain. The spring, 2009 (105 units) and summer, 2010 (92 units) scores were near the maximum of the range typical for such a site and higher than the historical median by 20 and 7 units respectively. The spring, 2009 score was 6 units higher than the maximum score previously recorded at this site. These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the lower reaches of a ringplain stream. The historical median score (85 units) placed this site in the 'fair' category for generic and 'expected' category for predictive methods of assessment.

3.2.13.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 53.

Table 53 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Punehu Stream at SH 45 between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	25	89	A	A
MOLLUSCA	*Potamopyrgus*	4	14	50		VA
EPHEMEROPTERA	*Deleatidium*	8	6	21	XA	XA
COLEOPTERA	Elmidae	6	16	57	VA	XA
MEGALOPTERA	*Archichauliodes*	7	3	11		
TRICHOPTERA	*Aoteapsyche*	4	12	43		A
	Hydrobiosis	5	16	57		
	Oxyethira	2	4	14		
	Pycnocentrodes	5	6	21	XA	VA
DIPTERA	*Aphrophila*	5	15	54	A	
	Maoridiamesa	3	15	54	A	A
	Orthocladiinae	2	27	96	A	A
	Tanytarsini	3	8	29		
	Ceratopogonidae	3	1	4		
	Empididae	3	6	21		
	Muscidae	3	2	7		
	Austrosimulium	3	3	11		

Prior to the current 2009-2010 period 17 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', five '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; three 'moderately sensitive' taxa (elmid beetles, free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)); and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)). Seven of the historically characteristic taxa were dominant in the spring 2009 community.

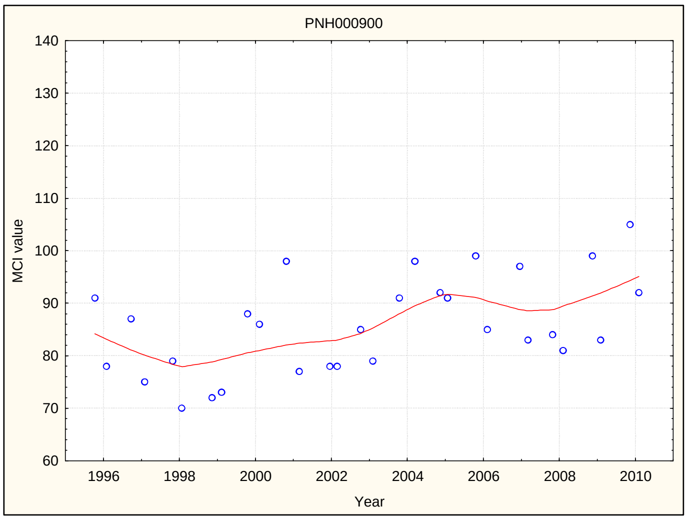
These comprised one 'highly sensitive', three 'moderately sensitive', and three 'tolerant' taxa, whereas one 'highly sensitive', two 'moderately sensitive', and five 'tolerant' taxa comprised the dominant taxa in the summer community. Six of these nine taxa were dominant in both spring and summer communities (Table 53). Despite an increase in the proportional dominance of 'tolerant' taxa and reduction in 'moderately sensitive' taxa, there was minimal difference in seasonal $SQMCI_s$ scores (Tables 150 and 151). The four taxa recorded as very or extremely abundant during spring and summer had characterised this site's communities on 21% to 57% of past surveys.

3.2.13.2.3Predicted 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 86 (altitude) and 98 (distance) for this site. The historical site median (85 units) is within one unit of the altitude prediction but a significant (Stark, 1998) 13 units lower than the distance predictive value. The spring, 2009 survey score (105 units) was higher than these predictive values and the summer, 2010 score (92 units) was within 6 units of predictive values. Of the 30 surveys to date at this site, 40% of MCI scores have been less than 86 units while only 10% have been greater than 98 units.

3.2.13.2.4Temporal trends in 1995 to 2010

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006), has been performed on the fifteen years of SEM results collected to date from the site, in the Punehu Stream at SH 45. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 49.



N = 30
Kendall tau = +0.347
p level = 0.007 [>FDR, p = 0.028]
Significant at p <0.05, and after FDR

Figure 49 LOWESS trend plot of MCI data at the SH 45 site

This site's MCI scores show a positive temporal trend over the fifteen year period which was statistically significant ($p<0.05$) after FDR application.

The LOWESS-smoothed MCI scores' range (18 units) was ecologically significant within this period with scores mainly indicative of 'poor' generic stream health (Table 1) prior to early 1999 improving to 'fair' health throughout the subsequent period. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, stream health fell in the 'expected' category almost throughout the period prior to improving to 'better than expected' in very recent times. An improvement in consented dairy shed discharge compliance in the local vicinity of the site has been coincidental with recent trends.

3.2.13.3 Discussion

Seasonal MCI values typically deteriorated between spring and summer at the mid-reach (Wiremu Road) site, although only by 3 units, whereas a more typical and significant decrease (13 units) was found at the lower reach site (SH 45). Seasonal communities at the mid reach site shared 20 common taxa (71% of the 28 taxa found at this site in 2009-2010) compared with 17 shared common taxa (68% of the 25 taxa found in 2009-2010) at the lower reaches site (SH 45) a typically slightly more pronounced seasonal change in community structure at the lower of the two sites. The two sites shared 16 common taxa (55% of the 29 taxa) in spring and 14 common taxa (47% of 30 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and summer and typically more so in summer.

MCI score typically fell in a downstream direction in both spring (by 23 units) and more markedly in summer (by 33 units), over a stream distance of 16.5 km through the mid to lower reaches of this stream. These falls in MCI scores equated to rates of decline of 1.4 units/km in spring increasing to 2.0 units/km in summer, compared with a predicted rate of 1.0 unit/km over the equivalent length and reach of a National Park-sourced stream (Stark and Fowles, 2009).

Using the long-term median SEM MCI scores for both sites (Appendix II), the overall rate of decline has been 2.4 MCI units/km over the surveyed length. Therefore rates of decline over the 2009 – 2010 period were lower in spring and similar in summer to rates prior to 2010.

3.2.14 Patea River

The results of spring (2009) and summer (2009-2010) surveys are presented in Table 152 and Table 153, Appendix I.

3.2.14.1 Barclay Road site (PAT000200)

3.2.14.1.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken at this upper reach, shaded site adjacent to the National Park boundary in the Patea River between 1995 and March 2009. These results are summarised in Table 54, together with the results from the current period, and illustrated in Figure 50.

Table 54 Results of previous surveys performed in the Patea River at Barclay Road, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000200	28	26-35	31	127-143	137	32	135	27	145

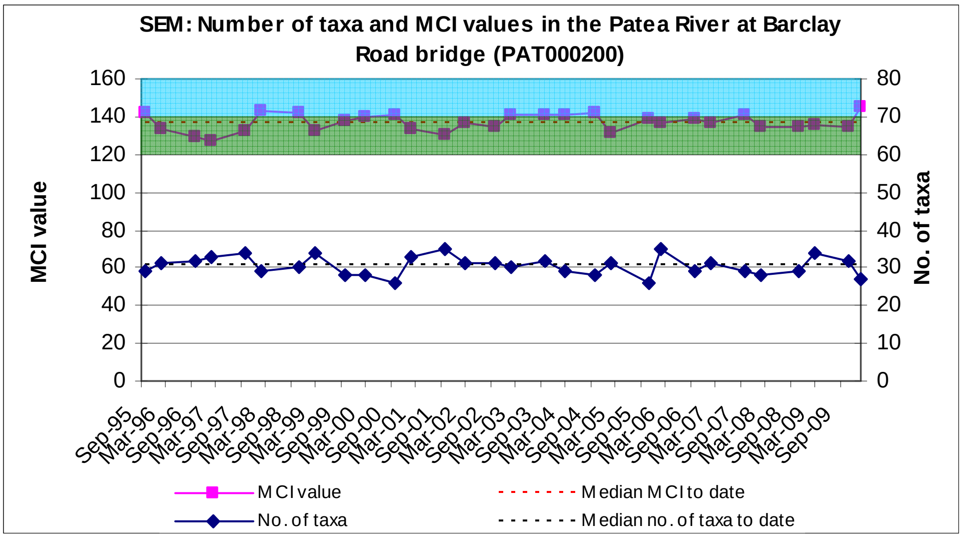


Figure 50 Numbers of taxa and MCI values in the Patea River at Barclay Road

A moderate range of richnesses (26 to 35 taxa) has been found with a relatively high median richness of 31 taxa, typical of richnesses in ringplain streams and rivers near the National Park boundary. During the 2009-2010 period spring (32 taxa) and summer (27 taxa) richnesses were within four taxa of this median richness coincident with very thin periphyton mat layers on the predominantly stony-bouldery substrate of this shaded site.

MCI values have had a moderate range (16 units) at this site, typical of a National Park boundary site. The high median value (137 units) has been typical of upper reach sites elsewhere on the ringplain, and the spring, 2009 (135 units) and summer, 2010 (145 units) scores continued this trend for such a site. These scores were 2 units lower and 8 units above the historical median respectively. The summer MCI score was 2 units higher than the previous maximum value at this site.

They categorised this site as having 'very good' (spring) and 'excellent' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health for the upper reaches of a ringplain stream on both of these occasions. The historical median score (137 units) placed this site in the 'very good' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.14.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 55.

Table 55 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Patea River at Barclay Road between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
EPHEMEROPTERA	*Austroclima*	7	4	14		A
	Coloburiscus	7	28	100	VA	VA
	Deleatidium	8	28	100	XA	XA
	Nesameletus	9	3	11		
PLECOPTERA	*Austroperla*	9	1	4		
	Megaleptoperla	9	13	46		
	Zelandobius	5	10	36	A	
	Zelandoperla	8	23	82	VA	
COLEOPTERA	Elmidae	6	27	96	A	A
	Hydraenidae	8	11	39		
MEGALOPTERA	*Archichauliodes*	7	7	25		
TRICHOPTERA	*Costachorema*	7	1	4		
	Hydrobiosis	5	1	4		
	Hydrobiosella	9	1	4		A
	Orthopsyche	9	20	71	A	A
	Beraeoptera	8	14	50	A	
	Helicopsyche	10	12	43		A
	Olinga	9	1	4		
	Zelolessica	7	1	4		
DIPTERA	*Aphrophila*	5	26	93	A	A
	Orthocladiinae	2	14	50		A
	Polypedilum	3	0	0		A

Prior to the current 2009-2010 period, 21 taxa had characterised the community at this site on occasions. These have comprised eleven 'highly sensitive', nine 'moderately sensitive', and one '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 seven 'highly sensitive' taxa (mayfly (*Deleatidium* on every sampling occasion), stoneflies (*Zelandoperla* and *Megaleptoperla*), hydraenid beetles, and caddisflies (*Orthopsyche*, *Beraeoptera*, and *Helicopsyche*)); four 'moderately sensitive' taxa ((mayfly (*Coloburiscus* on every occasion), stonefly (*Zelandobius*), elmid beetles, and cranefly (*Aphrophila*)); and only one 'tolerant' taxon (orthoclad midges). Eight of these taxa were dominant in the spring, 2009 community.

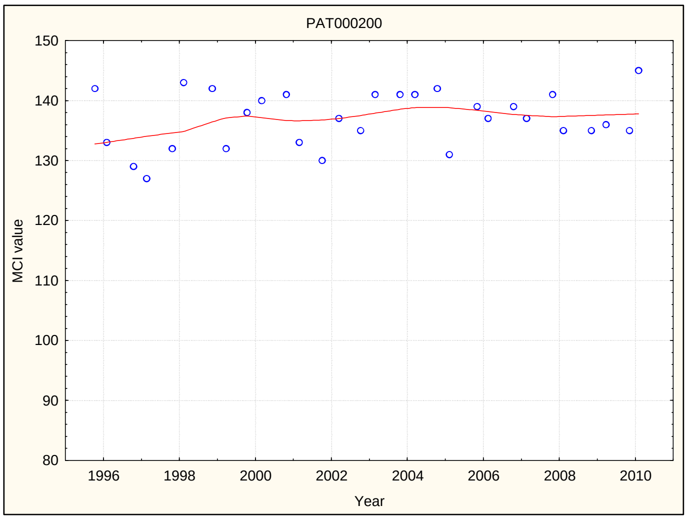
Five of these taxa again were dominant in the summer, 2010 community together with two other 'highly sensitive' taxa, two of the 'moderately sensitive' taxa and one of the 'tolerant' taxa historically characteristic of this site, together with another 'tolerant' taxon (midge (*Polypedilum*)), which, although found at this site previously, had not been a characteristic taxon. No 'tolerant' taxa were dominant in spring coincident with minimal periphyton substrate cover at this site. The relatively similar balances between 'highly' and 'moderately' sensitive taxa dominances was illustrated in the minimal difference of 0.1 unit in SQMCI$_s$ values (Tables 152 and 153).The three taxa recorded as very or extremely abundant during spring and/or summer had characterized this site's communities on 82% to 100% of past surveys.

3.2.14.1.3Predicted 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. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 135 (altitude) and 125 (distance) for this site. The historical site median (137 units) is only 2 units lower than the altitude prediction but a significant 12 units above the distance predictive value. The spring, 2009 survey score (135 units) was equal with or higher than these predictive values while the summer, 2010 score (145 units) was higher than both predictive values. Of the 30 surveys to date at this site, no MCI scores have been less than 125 units while 63% have been greater than 135 units.

3.2.14.1.4Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Patea River at Barclay Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 51.



N = 30
Kendall tau = +0.085
p value = 0.508 [>FDR, p = 0.662]
N/S at p <0.05

Figure 51 LOWESS trend plot of MCI data at the Barclay Road site

No statistically significant temporal trend in MCI scores has been found at this upper catchment site over the 15 year monitoring period and neither has the range of LOWESS-smoothed scores (6 units) shown ecological significance. Smoothed MCI scores have consistently indicated 'very good', bordering on 'excellent', generic river health (Table 1) at this relatively pristine site just outside the National Park boundary and in terms of predictive relationships (Table 2), river health has been 'better than expected' since 1998.

3.2.14.2 Swansea Road site (PAT000315)

3.2.14.2.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken in the Patea River at this mid-reach site at Swansea Road, Stratford between 1995 and March 2009. These results are summarised in Table 56, together with the results from the current period, and illustrated in Figure 52.

Table 56 Results of previous surveys performed in the Patea River at Swansea Road, prior to spring 2009, together with spring 2009 and summer 2010

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000315	28	20-32	27	99-130	110	27	119	26	108

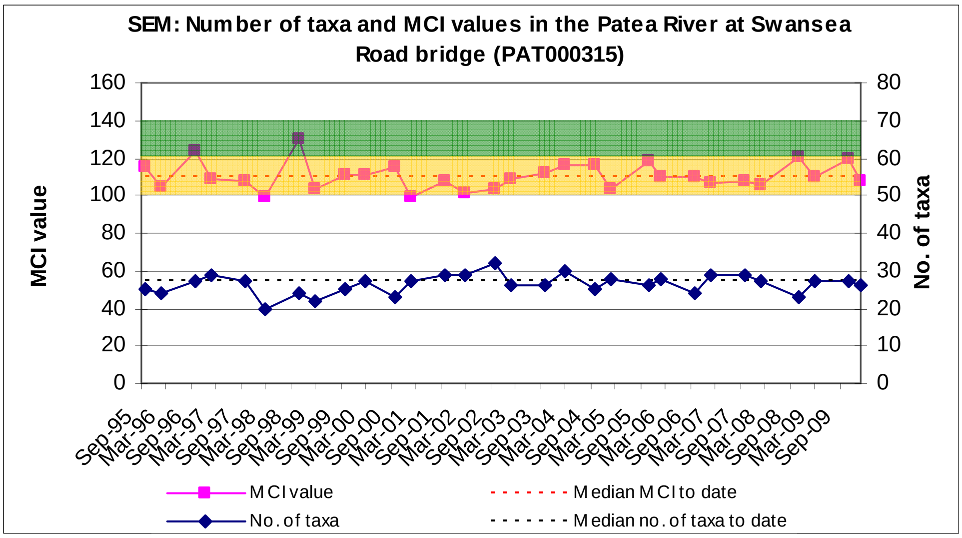


Figure 52 Numbers of taxa and MCI values in the Patea River at Swansea Road

A moderate range of richnesses (20 to 32 taxa) has been found, with a median richness of 27 taxa typical of richnesses in the mid reaches of ringplain streams and rivers. During the 2009-2010 period, spring (27 taxa) and summer (26 taxa) richnesses were very similar and almost equivalent with the median taxa number in spring and in summer, despite more extensive substrate periphyton cover and warmer summer water temperatures.

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 (110 units) has been relatively typical of mid-reach sites elsewhere on the ringplain however, with the spring, 2009 (119 units) and summer, 2010 (108 units) scores within nine units of the historical median. These scores categorised this site as having 'good' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the mid reaches of a ringplain river. The historical median score (110 units) placed this site in the 'good' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.14.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 57.

Table 57 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Patea River at Swansea Road between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	8	29		
EPHEMEROPTERA	*Austroclima*	7	13	46		
	Coloburiscus	7	28	100	XA	XA
	Deleatidium	8	21	75	XA	XA
	Nesameletus	9	8	29	A	VA
PLECOPTERA	*Acroperla*	5	4	14		
	Zelandoperla	8	9	32	A	
COLEOPTERA	Elmidae	6	16	57	A	VA
	Hydraenidae	8	4	14		
MEGALOPTERA	*Archichauliodes*	7	12	43		A
TRICHOPTERA	*Aoteapsyche*	4	21	75		VA
	Costachorema	7	18	64		
	Hydrobiosis	5	5	18		
	Neurochorema	6	4	14		
	Beraeoptera	8	6	21	A	
	Pycnocentrodes	5	2	7	A	
DIPTERA	*Aphrophila*	5	24	86	A	VA
	Eriopterini	5	1	4		
	Maoridiamesa	3	23	82		
	Orthocladiinae	2	27	96		A
	Tanytarsini	3	10	36		
	Muscidae	3	2	7		
	Austrosimulium	3	10	36		

Prior to the current 2009-2010 period, 23 taxa had characterised the community at this site on occasions. These have comprised five 'highly sensitive', eleven 'moderately sensitive', and seven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and an increase in 'tolerant' taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included two 'highly sensitive' taxa (mayfly (*Deleatidium*), and stonefly (*Zelandoperla*)); six 'moderately sensitive' taxa (mayflies (*Coloburiscus* and *Austroclima*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Costachorema*), and cranefly (*Aphrophila*)); and five 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*), midges (*Maoridiamesa*, orthoclads, and tanytarsids), and sandfly (*Austrosimulium*)). Eight of these historically characteristic taxa were dominant in the spring 2009 community. These comprised four 'highly sensitive' taxa and four 'moderately sensitive' taxa, whereas two 'highly sensitive', four 'moderately sensitive', and two 'tolerant' taxa comprised the dominant taxa of the summer community. Five of these eleven taxa were dominant in both spring and summer communities (Table 57). These relatively similar seasonal dominances amongst the six most abundant of these taxa were reflected in the small difference (0.4 unit) in $SQMCI_s$ scores (Tables 152 and 153).

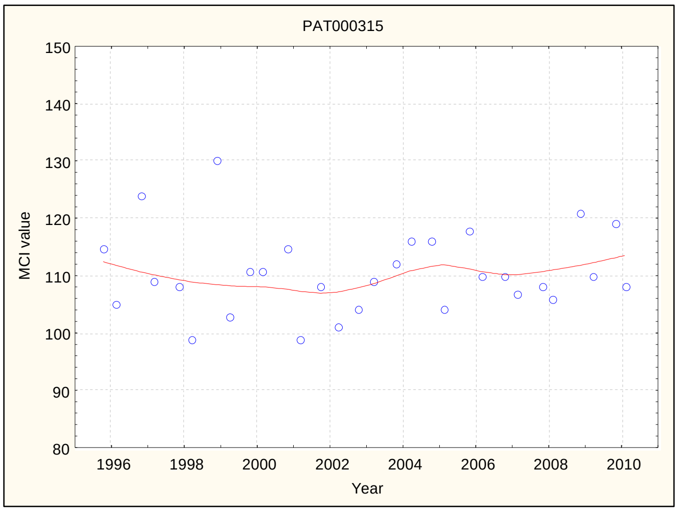
The six taxa found as very and/or extremely abundant by the seasonal surveys have characterised this site's communities on 29% to 100% of past survey occasions.

3.2.14.2.3 Predicted stream 'health'

The Patea River site at Swansea Road, Stratford is 12.9 km downstream of the National Park boundary at an altitude of 300 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 115 (altitude) and 103 (distance) for this site. The historical site median (110) is 5 units lower than the altitude prediction and 7 units higher than the distance predictive value while the spring, 2009 survey score (119 units) was 4 units higher than the predictive altitude value and a significant 16 units higher than the predictive distance value. The summer, 2010 score (108 units) was within 7 units of both predictive values. Of the 30 surveys to date at this site, 10% of MCI scores have been less than 103 units while 23% have been greater than 115 units.

3.2.14.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Patea River at Swansea Road . The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 53.



N = 30
Kendall tau = +0.075
p value = 0.561 [>FDR, p = 0.708]
N/S at p <0.05

Figure 53 LOWESS trend plot at the Swansea Road site

The very slight positive temporal trend in MCI scores was not statistically significant over the fifteen year period. The range of LOWESS-smoothed scores (6 units) was also insignificant ecologically. Smoothed MCI scores consistently indicated 'good' generic river health (Table 1) throughout the monitoring period. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain river, health has been 'better than expected' for the entire period.

3.2.14.3 Skinner Road site (PAT000360)

3.2.14.3.1 Taxa richness and MCI

Twenty-eight 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 1995 and March 2009. These results are summarised in Table 58, together with the results from the current period, and illustrated in Figure 54.

Table 58 Results of previous surveys performed in the Patea River at Skinner Road, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000360	28	15-33	24	86-104	97	21	98	22	105

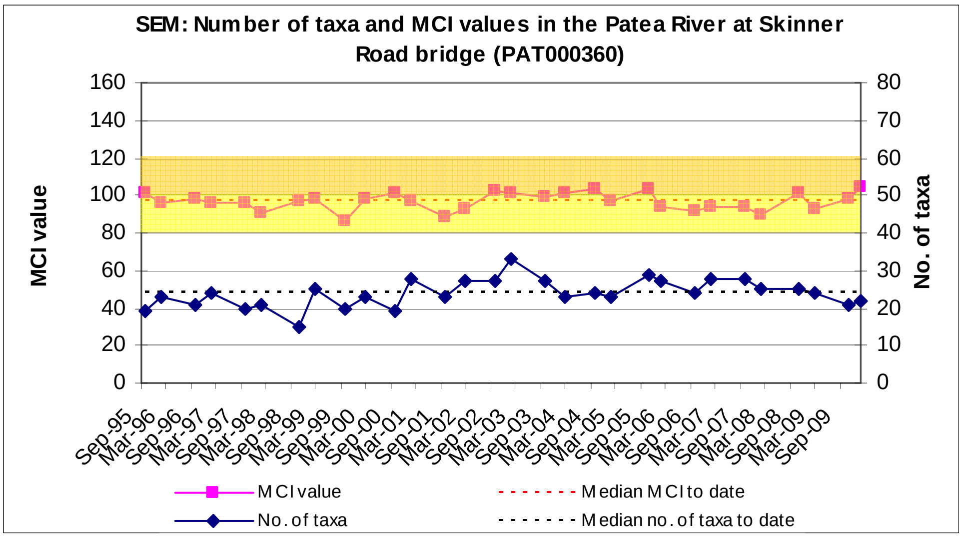


Figure 54 Numbers of taxa and MCI values in the Patea River at Skinner Road

A wide range of richnesses (15 to 33 taxa) has been found with a median richness of 24 taxa (more representative of typical richnesses in the mid-reaches of ringplain streams and rivers). During the 2009-2010 period spring (21 taxa) and summer (22 taxa) richnesses were very similar and slightly lower than the median taxa number on both occasions.

MCI values have had a moderate range (18 units) at this site, typical of sites in the mid-reaches of ringplain streams and rivers. The median value (97 units) has been relatively typical of the range of scores at mid-reach sites elsewhere on the ringplain however. The spring, 2009 (98 units) and summer, 2010 (105 units) scores were relatively similar and typical of scores for such a site and 1 to 8 units higher than the historical median. These scores categorised this site as having 'fair' to 'good' health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' to 'better than expected' health in spring and summer respectively for the mid-reaches of a ringplain river. The historical median score (97 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.14.3.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 59.

Table 59 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Patea River at Skinner Road between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	5	18		
ANNELIDA	Oligochaeta	1	21	75		A
MOLLUSCA	*Potamopyrgus*	4	9	32		A
CRUSTACEA	*Paracalliope*	5	1	4		
EPHEMEROPTERA	*Austroclima*	7	1	4		
	Coloburiscus	7	5	18	A	A
	Deleatidium	8	7	25	XA	VA
PLECOPTERA	*Acroperla*	5	2	7		
COLEOPTERA	Elmidae	6	20	71	A	VA
MEGALOPTERA	*Archichauliodes*	7	9	32		A
TRICHOPTERA	*Aoteapsyche*	4	21	75	A	XA
	Costachorema	7	7	25		A
	Hydrobiosis	5	14	50		A
	Oxyethira	2	4	14		
	Pycnocentrodes	5	6	21		
DIPTERA	*Aphrophila*	5	19	68	VA	A
	Maoridiamesa	3	23	82	VA	VA
	Orthocladiinae	2	28	100	VA	A
	Tanytarsini	3	14	50		A
	Empididae	3	2	7		
	Muscidae	3	8	29		
	Austrosimulium	3	8	29		

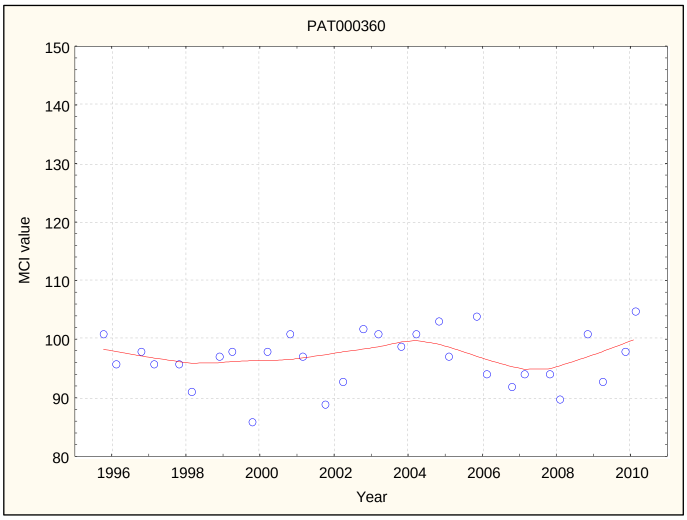
Prior to the current 2009-2010 period, 22 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportions of 'moderately sensitive' and 'tolerant' taxa as would be expected in the mid-reaches of a ringplain river. Predominant taxa have included four 'moderately sensitive' taxa (elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)); and six 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa*, tanytarsids and orthoclads)). Seven of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive', three 'moderately sensitive', and three 'tolerant' taxa, whereas one 'highly sensitive', five 'moderately sensitive', and six 'tolerant' taxa comprised the dominant taxa of the summer, 2010 community. Seven of these thirteen taxa were dominant in both spring and summer communities (Table 25). The increased summer dominance by 'tolerant' taxa in particular was reflected in the decrease of 1.6 units in $SQMCI_s$ scores between spring and summer (Tables 152 and 153). The six taxa found as very and/or extremely abundant by the seasonal surveys have characterised this site's communities on 25% to 100% of past survey occasions and all of these taxa were dominant in both spring and summer surveys.

3.2.14.3.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 109 (altitude) and 99 (distance) for this site. The historical site median (97) is a significant (Stark, 1998) 12 units lower than the altitude prediction but only two units lower than the distance predictive value. The spring, 2009 survey score (98 units) was 11 units lower than the altitude predictive value while the summer, 2010 score (105 units) was only 4 units lower than the predictive altitude value and 6 units above the predicted distance value. Of the 30 surveys to date at this site, 67% of MCI scores have been less than 99 units while no scores have been greater than 109, units, indicative of some deterioration in river 'health' when compared with the historical record at the nearest upstream site in Stratford township.

3.2.14.3.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Patea River at Skinner Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 55.



N = 30
Kendall tau = +0.064
p value = 0.619 [>FDR, p = 0.716]
N/S at p <0.05

Figure 55 LOWESS trend plot at the Skinner Road site

The weak positive temporal trend in MCI scores over the fifteen year period was not statistically significant. An apparent decline in scores between 2004 and 2008 has been followed by some recent improvement. The range of LOWESS-smoothed scores (6 units) had no ecological significance over the period. Smoothed MCI scores consistently indicated 'fair' generic river health (Table 1) briefly bordering on 'good' health six years ago and most recently. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain river, health has remained in the 'expected' category throughout the fifteen year period.

3.2.14.4 Discussion

Seasonal MCI values atypically improved between spring and summer at two sites (Barclay Road and Skinner Road) by 10 and 7 units respectively while at the Swansea Road, Stratford site a more typical summer decrease in MCI score (11 units) was recorded. Seasonal communities shared 69% of the 35 taxa common at the upper site, 56% of 34 taxa at Swansea Road, and 54% of 28 taxa at the furthest downstream site in the middle reaches indicative of increasing dissimilarities in seasonal community composition in a downstream direction.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream middle reaches site by 37 units in spring and 40 units in summer, over a river distance of 17.3 km. These seasonal falls in MCI scores equated to rates of decline of 2.1 units/km (spring) and 2.3 units/km (summer), compared with a predicted rate of 1.5 units/km for the equivalent length and reach of a National Park-sourced river (Stark and Fowles, 2009). This was more typical of the trend of past summer seasonal increases in rates of decline.

Between the upper reach site and Swansea Road mid-reach site, the spring (1.5 units/km) and summer (3.4 units/km) rates of decline were lower and far higher respectively than the predicted rate (2.0 units/km) for the equivalent river reach. For the Swansea Road mid-reach to Skinner Road mid-reach sites, spring (2.5 units/km) and summer (0.5 unit/km) rates of decline were far higher and very similar respectively to the predicted rate of 0.6 unit/km.

Using the long-term median SEM MCI scores for each site (Appendix II), the rates of decline between upper reach and Swansea Road mid-reach, and the Swansea Road mid-reach and Skinner Road mid-reach sites have been about 2.5 and 2.1 units per km respectively with an overall average rate of decline of 2.3 MCI units/km over the surveyed length. Therefore rates of MCI decline over the 2009-2010 period were more variable in summer than typical rates for the 1995 to 2009 period.

Community composition varied markedly through the upper to mid-reach length of the river surveyed. A total of 45 taxa was recorded in spring of which only 11 taxa were present at all three sites. These included two 'highly sensitive', seven 'moderately sensitive', and two 'tolerant' taxa with only the 'highly sensitive' ubiquitous mayfly *Deleatidium*; and three 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, and cranefly (*Aphrophila*)) abundant at all three sites. A slightly lower total of 40 taxa was found along the river's length by the summer survey of which eleven taxa also were present at all three sites. These were very similar to the eight widespread taxa in spring with the addition of one 'highly sensitive' (mayfly) taxon and loss of one 'tolerant' taxon. Only the one 'highly sensitive' mayfly, three 'moderately sensitive' taxa, and additional 'tolerant' orthoclad midges were abundant at all three sites. These dissimilarities in spatial community structure along the surveyed length (upper to mid-reaches) of the Patea River were just as pronounced in spring as in summer.

3.2.15 Mangaehu River

The results found by the 2009-2010 surveys are presented in Table 154 and Table 155 Appendix I for this single site in the lower reaches of a large eastern hill country river.

3.2.15.1 Raupuha Road site (MGH000950)

3.2.15.1.1Taxa richness and MCI

Twenty eight surveys have been undertaken at this lower reach site in the Mangaehu River between 1995 and March 2009. These results are summarised in Table 60, together with the results from the current period, and illustrated in Figure 56.

Table 60 Results of previous surveys performed in the Mangaehu River at Raupuha Road, prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGH000950	28	13-26	19	77-104	87	19	99	19	95

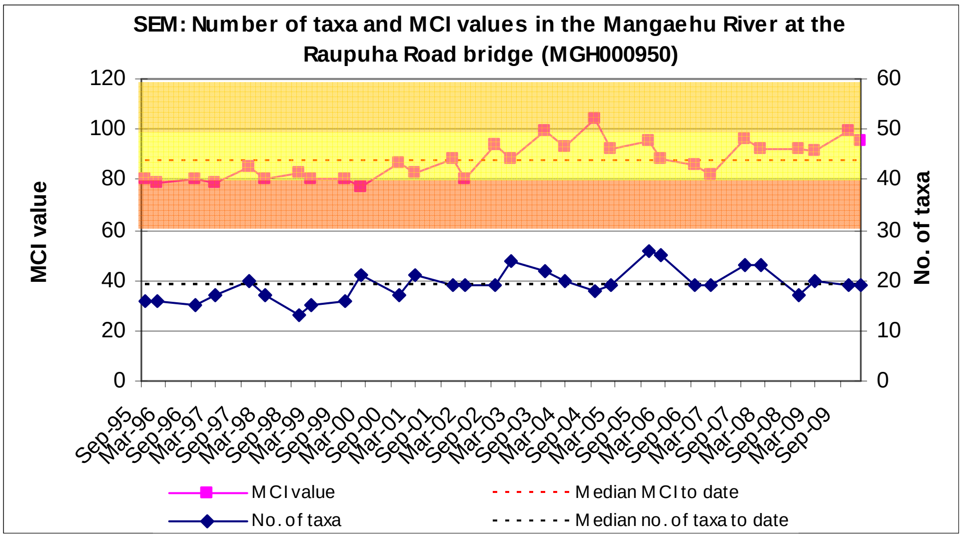


Figure 56 Numbers of taxa and MCI values in the Mangaehu River at Raupuha Road

A relatively wide range of richnesses (13 to 26 taxa) has been found with a moderate median richness of 19 taxa (lower than typical richnesses in the lower reaches of eastern hill country rivers). During the 2009-2010 period, spring and summer richnesses (19 taxa) were equivalent with this median richness.

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 (87 units) has been more typical of lower reach sites elsewhere and one unit less than the median score recorded by 35 previous surveys at 'control' sites located at similar altitudes (to the Raupuha Road site) in eastern hill country rivers and streams (TRC, 1999 (updated, 2009)). The spring, 2009 (99 units) and summer, 2010 (95 units) scores were 8 to 12 units higher than the historical median. These scores categorised this site as having 'fair' health generically (Table 1) in both spring and summer.

The historical median score (87 units) placed this site in the'fair' category for the generic method of assessment.

3.2.15.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 61.

Table 61 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Mangaehu River at Raupuha Road between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	1	4		
ANNELIDA	Oligochaeta	1	4	14		
MOLLUSCA	*Potamopyrgus*	4	9	32		
CRUSTACEA	*Paracalliope*	5	5	18		
EPHEMEROPTERA	*Austroclima*	7	3	11		A
	Mauiulus	5	1	4		
	Zephlebia group	7	2	7		
PLECOPTERA	*Acroperla*	5	7	25	A	
COLEOPTERA	Elmidae	6	2	7		A
TRICHOPTERA	*Aoteapsyche*	4	16	57		VA
	Costachorema	7	5	18		
	Hydrobiosis	5	13	46		A
	Oxyethira	2	2	7		
	Pycnocentrodes	5	10	36	VA	
DIPTERA	*Aphrophila*	5	22	79	VA	VA
	Maoridiamesa	3	18	64	VA	VA
	Orthocladiinae	2	26	93	VA	A
	Tanytarsini	3	11	39		
	Empididae	3	4	14		
	Muscidae	3	7	25		
	Austrosimulium	3	6	21		

Prior to the current 2009-2010 period, 21 taxa have characterised the community at this site on occasions. These have comprised no 'highly sensitive', ten '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 three 'moderately sensitive' taxa (caddisflies (*Hydrobiosis* and *Pycnocentrodes*), and cranefly (*Aphrophila*)); and five 'tolerant' taxa (snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa*, tanytarsids, and orthoclads). Four of these predominant taxa were dominant in the spring, 2009 community together with one other historically characteristic taxon. The summer, 2010 community was characterised by fewer of the taxa dominant in spring, together with an additional four taxa; all of which previously had been characteristic of this site's communities (Table 61). Despite several seasonal differences in characteristic taxa, the similarity in proportions of 'tolerant' taxa in spring and summer surveys was reflected in the minimal difference (0.4 unit) in seasonal $SQMCI_s$ scores (Tables 154 and 155).

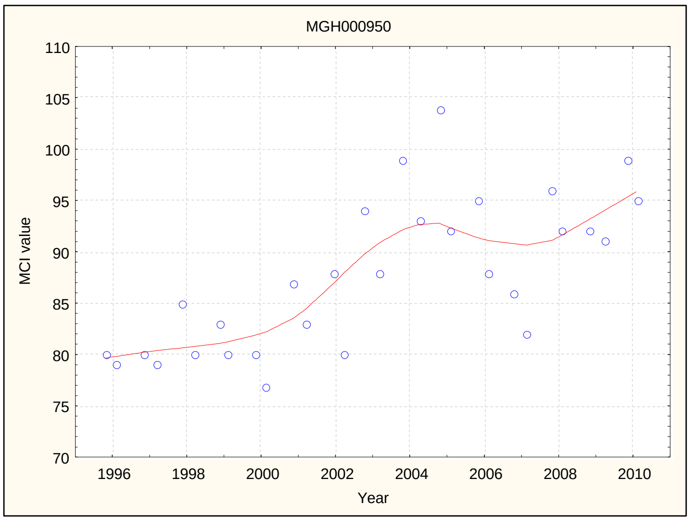
All taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 36% to 93% of the past surveys.

3.2.15.1.3 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. A relationship for ringplain streams and river developed between MCI and altitude (Stark and Fowles, 2009) is therefore not appropriate for this river.

3.2.15.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years (1995-2010) of SEM results collected to date from the site in the Mangaehu River at Raupuha Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 57.



N = 30
Kendall tau = +0.535
p value < 0.0001 [>FDR, p = 0.0003]
Significant at p<0.05 and p<0.01

Figure 57 LOWESS trend plot of MCI data for the Raupuha Road site

A strong statistical significant positive temporal trend in MCI scores (p<0.01 after FDR) was found at this lower river reach, eastern hill country site. This trend is partially explained by an apparent reduction in river bed sedimentation possibly related to fewer severe flood events particularly since 2000 with scores tending to plateau since peaking in 2004 before improving again most recently. The range of LOWESS-smoothed MCI scores (16 units) has also been ecologically significant, particularly over the period since 2000.

Smoothed MCI scores bordering on 'poor/fair' generic river health (Table 1) have trended upward into 'fair' where they currently remain (Figure 57).

3.2.15.2 Discussion

Seasonal MCI values typically decreased (although only by 4 units) between spring and summer at this lower reach site with the percentage community composition of 'tolerant' taxa 11% higher at the time of the summer survey. However, seasonal communities at this site shared only 14 common taxa (61% of the 24 taxa found at this site in 2009-2010), a moderate percentage of common taxa considering the similarity in MCI values for the seasonal surveys.

3.2.16 Waingongoro River

The results of spring (2009) and summer (2009-2010) surveys are summarised in Table 156 and Table 156, Appendix I.

3.2.16.1 Site near National Park boundary (WGG000115)

3.2.16.1.1Taxa richness and MCI

Twenty-eight surveys have been undertaken at this upper reach site, 700m downstream of the National Park boundary in the Waingongoro River, between 1995 and March 2009. These results are summarised in Table 62, together with the results from the current period, and illustrated in Figure 58.

Table 62 Results of previous surveys performed in the Waingongoro River 700m downstream of the National Park, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		February 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000115	28	24-40	32	122-139	133	31	126	32	128

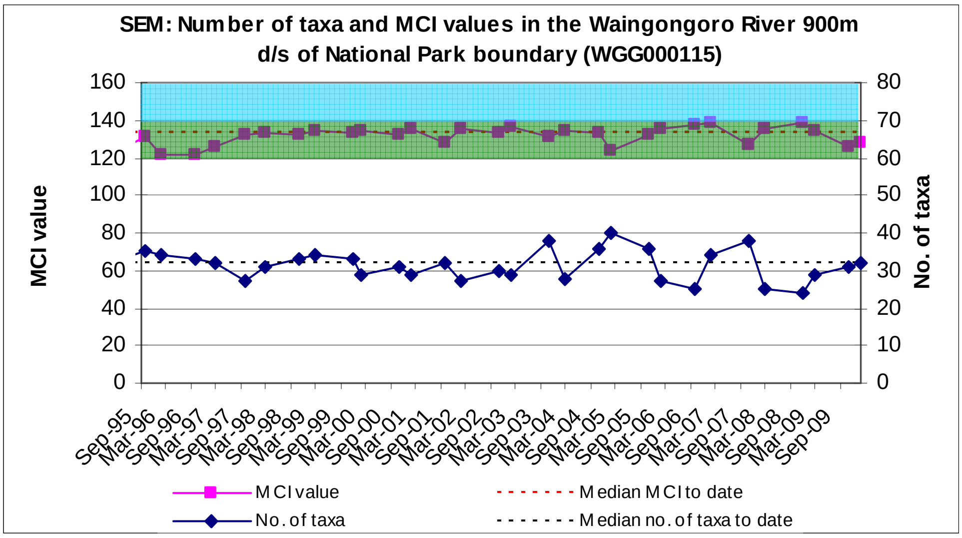


Figure 58 Numbers of taxa and MCI values in the Waingongoro River 700 m d/s National Park

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 2009-2010 period spring (31 taxa) and summer (32 taxa) richnesses were very similar to this median richness.

MCI values have had a moderate range (17 units) at this site, typical of a National Park boundary site. The median value (133 units) also has been typical of upper reach sites elsewhere on the ringplain and the spring, 2009 (126 units) and summer, 2010 (128 units) scores within 7 units of the historical median. They categorised this site as having 'very good' (spring) and 'very good' (summer) health generically (Table 1) but, in terms of predictive relationships (Table 2), 'worse than expected' health for the upper reaches of a ringplain stream on these occasions. The historical median score (133 units) placed this site in the 'very good' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.16.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 63.

Table 63 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waingongoro River 700 m downstream of the National Park between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
EPHEMEROPTERA	*Austroclima*	7	17	61	A	
	Coloburiscus	7	28	100	VA	A
	Deleatidium	8	28	100	XA	XA
	Nesameletus	9	15	54		
PLECOPTERA	*Acroperla*	5	2	7	A	
	Austroperla	9	1	4		
	Megaleptoperla	9	25	89	A	A
	Stenoperla	10	3	11		
	Zelandobius	5	2	7		
	Zelandoperla	8	28	100	VA	A
COLEOPTERA	Elmidae	6	28	100	VA	A
	Hydraenidae	8	22	79		
MEGALOPTERA	*Archichauliodes*	7	7	25		
TRICHOPTERA	*Aoteapsyche*	4	26	93	A	
	Beraeoptera	8	22	79	A	
	Helicopsyche	10	14	50	A	
	Olinga	9	22	79		
	Pycnocentrodes	5	1	4		
	Zelolessica	7	8	29	A	
DIPTERA	*Aphrophila*	5	28	100	A	A
	Maoridiamesa	3	2	7		
	Orthocladiinae	2	13	46		A

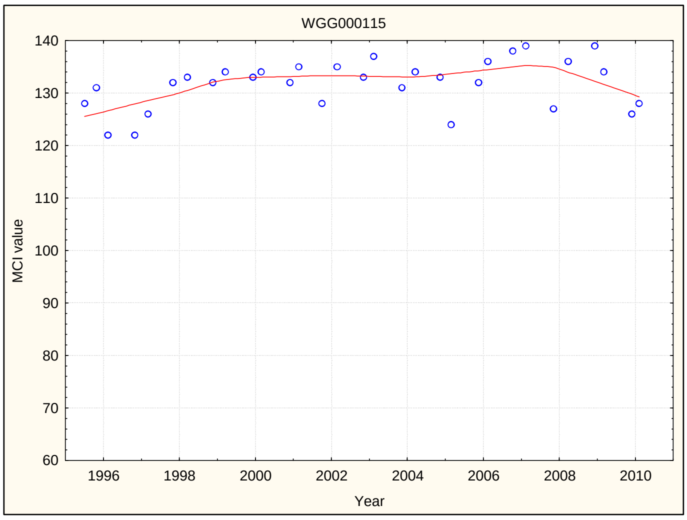
Prior to the current 2009-2010 period, 22 taxa had characterised the community at this site on occasions. These have comprised ten 'highly sensitive', nine 'moderately sensitive', and three 'tolerant' taxa i.e. a higher proportion of 'highly sensitive' taxa as might be expected in the upper reaches of 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 two 'tolerant' taxa (free-living caddisfly (*Aoteapsyche*) and orthoclad midges). Five of these taxa have been characteristic of communities on every occasion to date. Twelve of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised five 'highly sensitive' taxa, six 'moderately sensitive' taxon, and one 'tolerant' taxon, whereas three 'highly sensitive' taxa, three 'moderately sensitive' taxa, and one 'tolerant' taxon comprised the dominant taxa of the summer community. Six of these thirteen taxa were dominant in both spring and summer communities. All five taxa dominant on every previous survey occasion were included amongst these six taxa (Table 63). The relatively similar seasonal dominances by high proportions of 'sensitive' taxa were reflected in the minimal difference (0.3 unit) in $SQMCI_s$ scores (Tables 156 and 157).

3.2.16.1.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 140 (altitude) and 130 (distance) for this site. The historical site median (133 units) is 7 units lower than the altitude prediction and 3 units higher than the distance predictive value, while the spring, 2009 survey score (126 units) was significantly lower than the altitude predictive value and the summer, 2010 score (128 units) was also significantly lower (Stark, 1998) than this predictive value. Of the 30 surveys to date at this site, 27% of MCI scores have been less than 130 units while none have been greater than 140 units.

3.2.16.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Waingongoro River near the National Park. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 59.



N = 31
Kendall tau = +0.292
p value = 0.021 [>FDR, p = 0.068]
Significant at p<0.05;
N/S after FDR application

Figure 59 LOWESS trend plot of MCI data at the site near the National Park

A temporal trend of improvement of MCI scores has been found over the fifteen year period. This has been statistically significant at the 5% level but not with FDR applied. Most recently there has been some decline but the overall range of LOWESS-smoothed MCI scores remains close to ecologically significant (10 units). Throughout the period, smoothed MCI scores have indicated 'very good' generic river health (Table 1), while in terms of predictive relationships (Table 2) for a site in the upper reaches of a ringplain stream near the boundary of the National Park, river health has improved from 'worse than expected' to 'expected', where it has remained for the majority of the fifteen year period.

3.2.16.2 Opunake Road site (WGG000150)

3.2.16.2.1Taxa richness and MCI

Twenty-eight 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 1995 and March 2009. These results are summarised in Table 64, together with the results from the current period, and illustrated in Figure 60.

Table 64 Results of previous surveys performed in the Waingongoro River at Opunake Road, prior to spring 2009, together with spring 2009 and summer 2010 results.

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		February 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000150	28	24-39	28	119-139	128	24	138	27	129

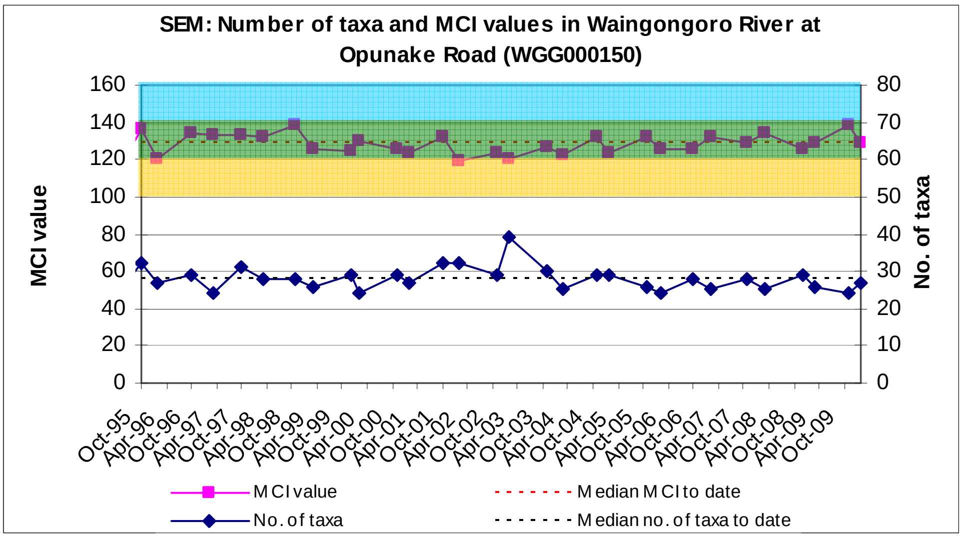


Figure 60 Numbers of taxa and MCI values in the Waingongoro River at Opunake Road

A relatively wide range of richnesses(24 to 39 taxa) has been found; wider than might be expected, with a median richness of 28 taxa (more representative of typical richnesses in the upper mid reaches of ringplain streams and rivers). During the 2009-2010 period spring (24 taxa) and summer (27 taxa) richnesses were slightly different (by 3 taxa); slightly below median taxa number in spring, but near median richness in summer, although substrate periphyton cover remained minimal.

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 (128 units) has been higher than typical of mid reach sites elsewhere on the ringplain however, with the spring, 2009 (138 units) and summer, 2010 (129 units) scores above those typical for such a site and 1 to 10 units above the historical median. These scores categorised this site as having 'very good' (spring) and 'very good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'well above expected' health on both occasions for the mid reaches of a ringplain river. The historical median score

(128 units) placed this site in the 'very good' and 'well above expected' categories for generic and predictive methods of assessment respectively.

3.2.16.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 65.

Table 65 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waingongoro River at Opunake Road between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	2	7		
EPHEMEROPTERA	*Austroclima*	7	22	79		
	Coloburiscus	7	28	100	XA	VA
	Deleatidium	8	28	100	XA	XA
	Nesameletus	9	23	82	A	A
PLECOPTERA	*Acroperla*	5	1	4		
	Megaleptoperla	9	2	7		
	Zelandoperla	8	20	71	A	
COLEOPTERA	Elmidae	6	28	100	VA	A
	Hydraenidae	8	19	68		
MEGALOPTERA	*Archichauliodes*	7	17	61	A	
TRICHOPTERA	*Aoteapsyche*	4	23	82	A	
	Costachorema	7	1	4		
	Hydrobiosis	5	3	11		
	Beraeoptera	8	23	82	VA	
	Confluens	5	2	7		
	Helicopsyche	10	0	0	A	
	Olinga	9	7	25	A	
	Pycnocentrodes	5	11	39	A	A
DIPTERA	*Aphrophila*	5	28	100	VA	A
	Eriopterini	5	1	4		
	Orthocladiinae	2	6	21		

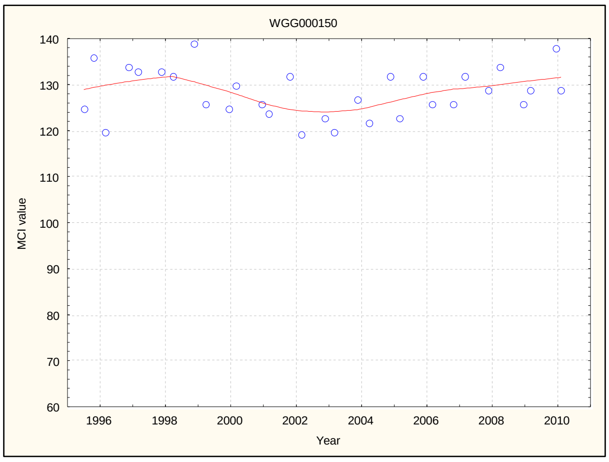
Prior to the current 2009-2010 period, 21 taxa had characterised the community at this site on occasions. These have comprised seven 'highly sensitive', eleven 'moderately sensitive', and three 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected toward the upper mid-reaches of a 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*)); six 'moderately sensitive' taxa (mayflies (*Coloburiscus* and *Austroclima*), elmid beetles, dobsonfly (*Archichauliodes*), caddisfly (*Pycnocentrodes*) and cranefly (*Aphrophila*)); and one 'tolerant' taxon (net-building caddisfly (*Aoteapsyche*)). Eleven of these taxa were dominant in the spring, 2009 community. These were comprised of five 'highly sensitive', five 'moderately sensitive' and one 'tolerant' taxa together with an additional 'highly sensitive' taxon (spiral stony-cased caddisfly, *Helicopsyche*) which had not been a characteristic taxon at this site previously. Six of these were again dominant in the summer, 2010 community when four fewer 'highly sensitive' taxa and one 'moderately sensitive' and 'tolerant' taxa were dominant. One taxon ('highly sensitive' mayfly, *Deleatidium*) was recorded as extremely abundant in both spring and summer communities. Despite the decrease in number of dominant taxa in the summer community, the numerical dominance by 'highly sensitive' taxa in both seasons was refleted in the similarity in seasonal $SQMCI_s$ values which differed by only 0.1 unit (Tables 156 and 157). All taxa recorded as very or extremely abundant during spring and/or summer had characterized this site's communities on 82% to 100% of past surveys. The four taxa recorded as very or extremely abundant during spring and/or summer have characterized this site's communities on every past survey occasion.

3.2.16.2.3Predicted 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 123 (altitude) and 110 (distance) for this site. The historical site median (128) is 5 units higher than the altitude prediction and a significant (Stark, 1998) 18 units higher than the distance predictive value while the spring, 2009 survey score (138 units) was significantly higher than both predictive values and within one unit of the historical maximum score. The summer, 2010 score (129 units) was higher than both predictive values by 6 to a significant 19 units. Of the 30 surveys to date at this site, no MCI scores have been less than 110 units while 80% have been greater than 123 units, further indicative of the better than predicted health of the river at this site.

3.2.16.2.4Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Waingongoro River at Opunake Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 61.



N = 31
Kendall tau = -0.016
p value = 0.902 [>FDR, p = 0.949]
N/S at $p < 0.05$

Figure 61 LOWESS trend plot of MCI data at the Opunake Road site

An overall temporal trend of a very slight decrease in MCI scores has not been statistically significant at this site in the upper mid-reaches (some 7km below the National Park) of the river. Localised erosion had caused sediment deposition on the riverbed during 1999 with a subsequent five year decline in MCI scores which was of no ecological significance (LOWESS-smoothed range of 7 units). This decline ceased with a gradual improvement in MCI scores towards earlier levels over the most recent seven years. The erosion event was very localised and site specific, as corresponding biological physiochemical monitoring data showed no significant trends at the nearest downstream site (Eltham Road). Smoothed MCI score have been consistently indicative of 'very good' generic river health (Table 1) although trending downward toward 'good' immediately following the erosion event. In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain river, health has been 'well above expected' for the entire period.

3.2.16.3 Eltham Road site (WGG000500)

3.2.16.3.1 Taxa richness and MCI

Thirty-one surveys have been undertaken in the Waingongoro River at this mid-reach site at Eltham Road between October 1995 and March 2009. These results are summarised in Table 66, together with the results from the current period, and illustrated in Figure 62.

Table 66 Results of previous surveys performed in the Waingongoro River at Eltham Road, prior to spring 2009, together with spring 2009 and summer 2010 results.

Site code	SEM data (1995 to Mar 2009)						2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		February 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000500	31	16 - 32	23	91-115	101	22	111	22	105

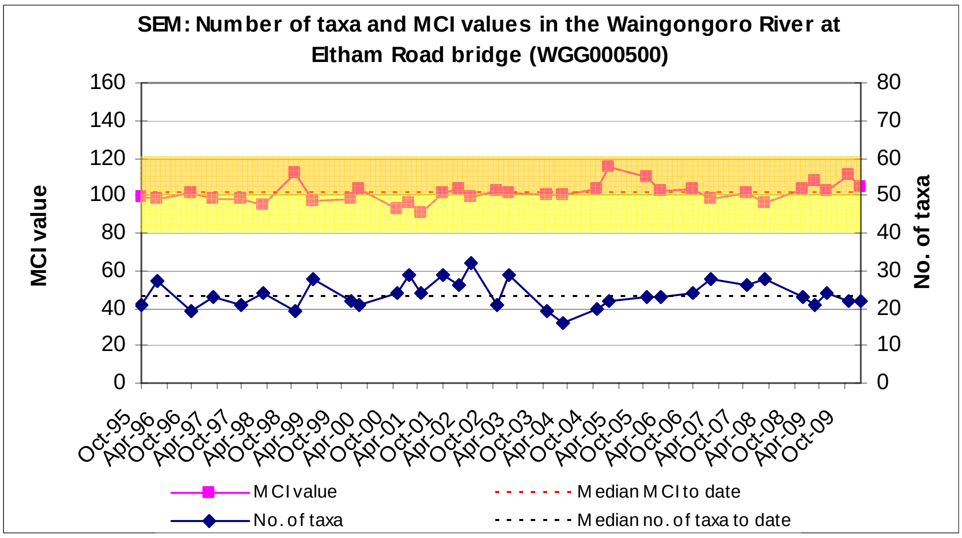


Figure 62 Numbers of taxa and MCI values in the Waingongoro River at Eltham Road

A wide range of richnesses (16 to 32 taxa) has been found with a median richness of 23 taxa, typical of richnesses in the mid reaches of ringplain streams and rivers. During the 2009-2010 period spring (22 taxa) and summer (22 taxa) richnesses were identical and very similar to the median taxa number in both seasons.

MCI values have had a moderate range (24 units) at this site, typical of sites in the mid reaches of ringplain rivers. The median value (101 units) has been relatively typical of mid reach sites elsewhere on the ringplain with the spring, 2009 (111 units) and summer, 2010 (105 units) scores typical for such a site and above the historical median by 4 to 10 units. These scores categorised this site as having 'good' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the mid reaches of a ringplain river. The historical median score (101 units) placed this site in the 'good' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.16.3.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 67.

Table 67 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waingongoro River at Eltham Road between 1995 and March 2009 [31 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	4	13		
ANNELIDA	Oligochaeta	1	12	39		
MOLLUSCA	*Potamopyrgus*	4	7	23		
EPHEMEROPTERA	*Austroclima*	7	8	26		
	Coloburiscus	7	14	45	A	A
	Deleatidium	8	20	65	XA	XA
PLECOPTERA	*Zelandobius*	5	4	13		
COLEOPTERA	Elmidae	6	30	97	VA	VA
MEGALOPTERA	*Archichauliodes*	7	17	55	A	A
TRICHOPTERA	*Aoteapsyche*	4	26	84	XA	VA
	Costachorema	7	15	48	A	
	Hydrobiosis	5	21	68	A	A
	Beraeoptera	8	1	3		
	Oxyethira	2	2	6		
	Pycnocentrodes	5	9	29		
DIPTERA	*Aphrophila*	5	7	23		
	Eriopterini	5	6	19		
	Maoridiamesa	3	16	52	A	
	Orthocladiinae	2	23	74		
	Tanytarsini	3	8	26		A
	Ceratopogonidae	3	1	3		
	Empididae	3	3	10		
	Austrosimulium	3	13	42		

Prior to the current 2009-2010 period, 23 taxa had characterised the community at this site on occasions. These have comprised two '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

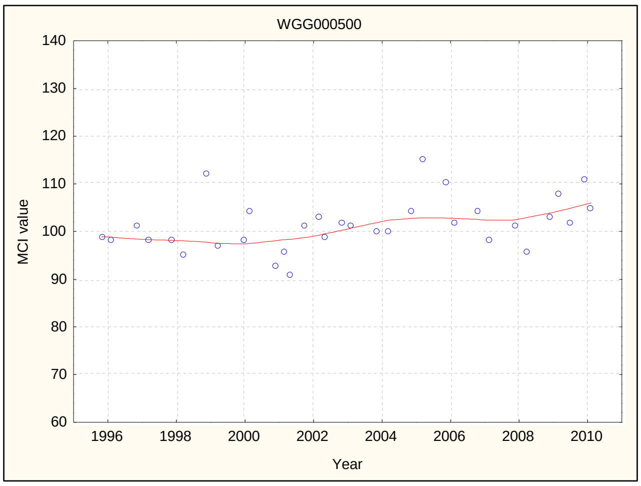
(*Deleatidium*)); five 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, free-living caddisflies (*Costachorema* and *Hydrobiosis*), and dobsonfly (*Archichauliodes*); and five 'tolerant' taxa (oligochaete worms, free-living caddisfly (*Aoteapsyche*), midges (*Maoridiamesa* and orthoclads), and sandfly (*Austrosimulium*)). Eight of these historically characerisctic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive' taxon, five 'moderately sensitive' taxa, and two 'tolerant' taxa, whereas one 'highly sensitive', four 'moderately sensitive', and two 'tolerant' taxa comprised the dominant taxa of the summer community. Six of these nine taxa were dominant in both spring and summer communities (Table 67). Despite relatively similar seasonal dominances, there was a small increase (0.9 unit) in $SQMCI_s$ scores between spring and summer principally due to the absence of one 'moderately sensitive' taxon in summer and the increased abundance of the caddisfly, *Aoteapsyche* in spring (Tables 156 and 157). The three taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 65% to 75% of past survey occasions.

3.2.16.3.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 105 (altitude) and 97 (distance) for this site. The historical site median (101) is 4 units lower than the altitude prediction and 4 units higher than the distance predictive value while the spring, 2009 survey score (111 units) was 6 to a significant 14 units above predictive values and the summer, 2010 score (105 units) was equal with the predictive altitude value and 8 units above the predictive distance value. Of the 33 surveys to date at this site, 15% of MCI scores have been less than 97 units while 15% have been greater than 105 units.

3.2.16.3.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Waingongoro River at Eltham Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 63.



N = 33
Kendall tau = +0.330
p value = 0.007 [>FDR, p = 0.028]
Significant at p < 0.05; and after FDR application

Figure 63 LOWESS trend plot of MCI data at the Eltham Road site

A positive temporal trend in MCI sores has been found over the fifteen-year period which has been statistically significant at the 5% level and after FDR application. This has been more pronounced since 2001 but scores plateaued for about three years before a more recent very gradual improvement. The narrow range of LOWESS-smoothed range of scores (8 units) has no ecological significance over the fifteen year period. MCI scores consistently bordered on ‘fair’ to ‘good’ generic river health (Table 1) with a tendency to remain ‘good’ since 2003. In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain river, health has been ‘better than expected’ since 2003, prior to which it had fallen in the ‘expected’ category.

3.2.16.4 Stuart Road site (WGG000665)

3.2.16.4.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken in the Waingongoro River at this mid-reach site at Stuart Road between 1995 and March 2009. These results are summarised in Table 68, together with the results from the current period, and illustrated in Figure 64.

Table 68 Results of previous surveys performed in the Waingongoro River at Stuart Road, prior to spring 2009, together with spring 2009 and summer 2010 results.

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		February 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000665	28	14-30	20	77-105	93	17	94	23	93

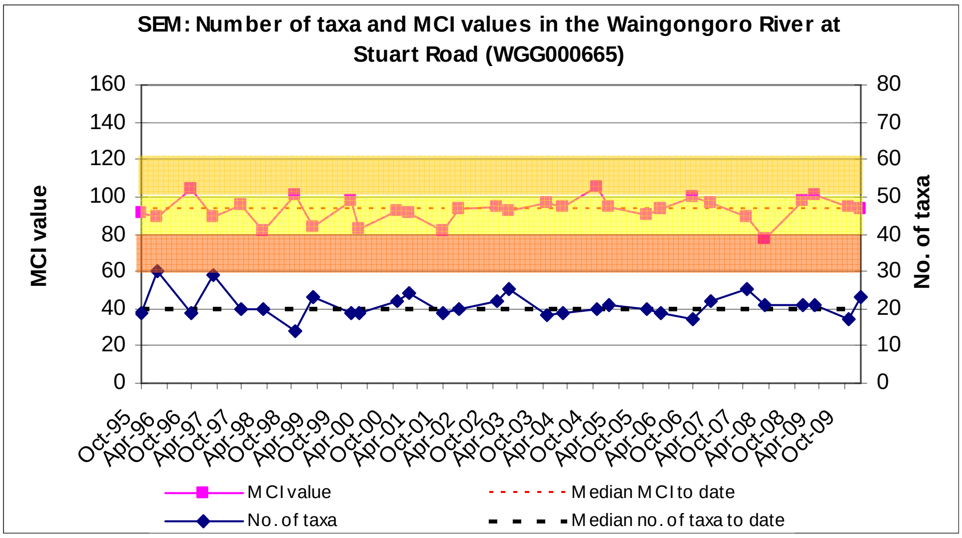


Figure 64 Numbers of taxa and MCI values in the Waingongoro River at Stuart Road

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 2009-2010 period spring (17 taxa) and summer (23 taxa) richnesses were different (by 6 taxa); slightly lower than the median taxa number in spring and slightly higher than median richness in summer, when substrate periphyton cover was more extensive.

MCI values have had a moderate range (28 units) at this site, typical of sites in the mid reaches of ringplain rivers. The median value (93 units) has been slightly lower than typical of mid reach sites elsewhere on the ringplain however, with the spring, 2009 (94 units) and summer, 2010 (93 units) scores typical of this site and within one unit of the historical median. These scores categorised this site as having 'fair' (spring) and 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health on both occasions for the mid reaches of a ringplain river. The historical median score (93 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.16.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 69.

Table 69 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waingongoro River at Stuart Road between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	1	4		
ANNELIDA	Oligochaeta	1	18	64		
CRUSTACEA	Ostracoda	1	1	4		
EPHEMEROPTERA	*Austroclima*	7	5	18		
	Coloburiscus	7	1	4		
	Deleatidium	8	12	43	XA	A
PLECOPTERA	*Zelandobius*	5	2	7		
COLEOPTERA	Elmidae	6	21	75	VA	VA
TRICHOPTERA	*Aoteapsyche*	4	23	82	VA	XA
	Costachorema	7	4	14	A	A
	Hydrobiosis	5	11	39		A
	Oxyethira	2	1	4		
	Pycnocentrodes	5	2	7		
DIPTERA	*Aphrophila*	5	11	39	A	
	Maoridiamesa	3	20	71	VA	XA
	Orthocladiinae	2	28	100	A	VA
	Tanytarsini	3	7	25		A
	Ceratopogonidae	3	1	4		
	Empididae	3	2	7		
	Austrosimulium	3	11	39		

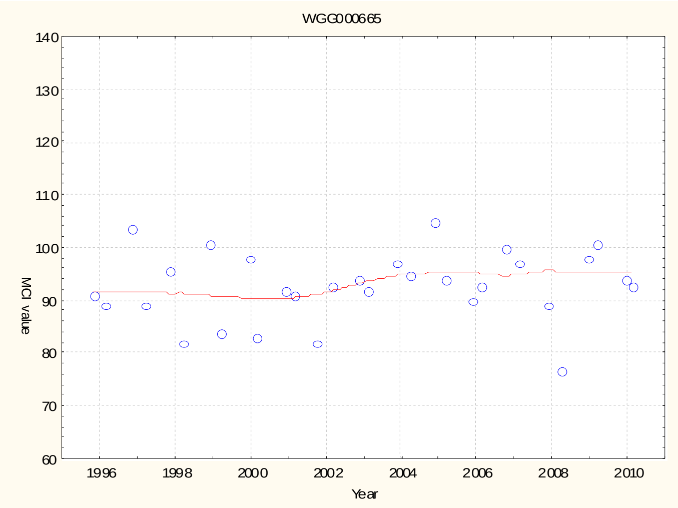
Prior to the current 2009-2010 period, 20 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', eight 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a high proportion of 'tolerant' taxa as might be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); three 'moderately sensitive' taxa (elmid beetles, free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)); and five 'tolerant' taxa (oligochaete worms, free-living caddisfly (*Aoteapsyche*), midges (*Maoridiamesa* and orthoclads), and *Austrosimulium*)). Seven of these historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive' taxon, three 'moderately sensitive' taxa, and three 'tolerant' taxa, whereas one 'highly sensitive', three 'moderately sensitive', and four 'tolerant' taxa comprised the dominant taxa of the summer community. Six of these nine taxa were dominant in both spring and summer communities (Table 69). An increased numerical dominance by 'tolerant' taxa and within certain of these taxa (e.g. midges and caddisfly) and a marked decrease in number within the 'highly sensitive' mayfly taxon in summer were reflected in the significant difference (2.8 units) in seasonal $SQMCI_s$ scores (Tables 156 and 157). All taxa (five) recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 43% to 100% of past survey occasions.

3.2.16.4.3Predicted 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 103 (altitude) and 94 (distance) for this site. The historical site median (93) is 10 units lower than the altitude prediction and one unit higher than the distance predictive value. The spring, 2009 survey score (94 units) was within 9 units of both predictive values and the summer, 2010 score (93 units) was lower than both predictive values by 1 to 10 units. Of the 30 surveys to date at this site, 57% of MCI scores have been less than 94 units while only 7% have been greater than 103 units.

3.2.16.4.4Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Waingongoro River at Stuart Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 65.



N = 30
Kendall tau = +0.140
p value = 0.276 [>FDR, p = 0.422]
N/S at p <0.05

Figure 65 LOWESS trend plot of MCI data at the Stuart Road site

No overall statistically significant trendin MCI scores has been found over the period with a gradual improvement in MCI scores since 2002 (coincident with summer diversion of the treated meatworks wastes discharge (at Eltham) from the river to landirrigation). The LOWESS-smoothed range of scores (6 units) was also ecologically insignificant over the fifteen year period. Smoothed MCI scores consistently have been indicative of 'fair' generic river health (Table 1) throughout the monitoring period. In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain river, health has been in the 'expected' category throughout the entire period.

3.2.16.5 SH45 site (WGG000895)

3.2.16.5.1 Taxa richness and MCI

Twenty-nine surveys have been undertaken in the Waingongoro River at this lower reach site at SH45 between 1995 and March 2009. These results are summarised in Table 70, together with the results from the current period, and illustrated in Figure 66.

Table 70 Results of previous surveys performed in the Waingongoro River at SH45 prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		February 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000895	29	16-24	21	73-105	95	16	98	21	95

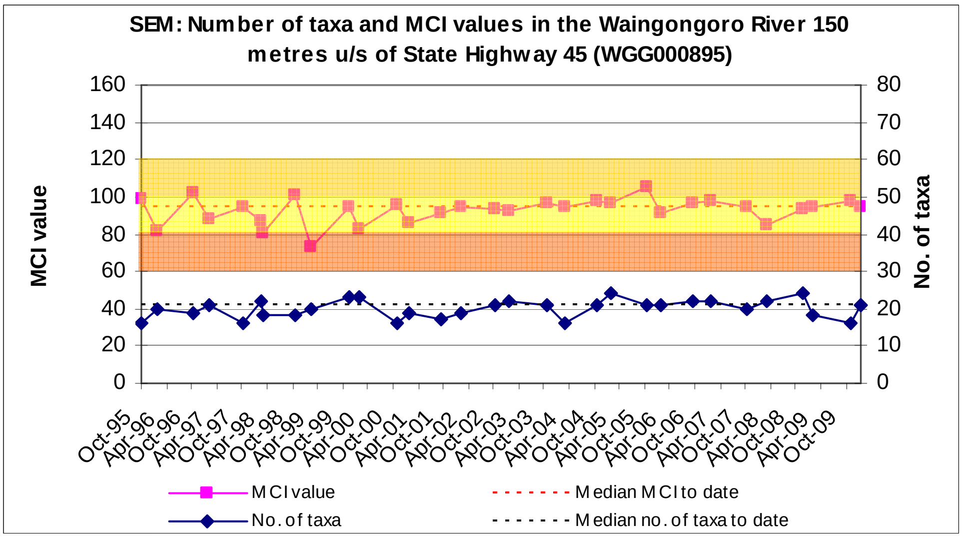


Figure 66 Numbers of taxa and MCI values in the Waingongoro River 150 m u/s of SH45

A moderate range of richnesses (16 to 24 taxa) has been found with a median richness of 21 taxa (more representative of typical richnesses in the lower reaches of ringplain streams and rivers). During the 2009-2010 period spring (16 taxa) and summer (21 taxa) richnesses varied by 5 taxa with the spring richness lower than the median taxa number by 5 taxa.

MCI values have had a wide range (32 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (95 units) has been slightly higher than typical of scores at lower reach sites elsewhere on the ringplain (TRC, 1999 (updated, 2009)), however. The spring, 2009 (98 units) and summer, 2010 (95 units) scores were similar, typical of scores at this site, and were within 3 units of the historical median. These scores categorised this site as having 'fair' health generically (Table 1) on both occasions and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the lower reaches of a ringplain river. The historical median score (95 units) placed this site in the 'fair' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.16.5.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 71.

Table 71 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waingongoro River at SH45 between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	3	10		
ANNELIDA	Oligochaeta	1	23	79	VA	A
	Lumbricidae	5	3	10	A	
MOLLUSCA	*Latia*	5	2	7		
	Potamopyrgus	4	27	93	A	VA
EPHEMEROPTERA	*Austroclima*	7	3	10		
	Deleatidium	8	12	41	VA	A
PLECOPTERA	*Zelandobius*	5	3	10		
COLEOPTERA	Elmidae	6	29	100	A	VA
MEGALOPTERA	*Archichauliodes*	7	3	10		
TRICHOPTERA	*Aoteapsyche*	4	29	100	XA	XA
	Costachorema	7	2	7		
	Hydrobiosis	5	15	52	A	A
	Pycnocentrodes	5	27	93	VA	VA
DIPTERA	*Aphrophila*	5	10	34		
	Maoridiamesa	3	16	55		
	Orthocladiinae	2	18	62		A
	Tanytarsini	3	5	17		
	Austrosimulium	3	5	17		

Prior to the current 2009-2010 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*)); four 'moderately sensitive' taxa (elmid beetles, caddisflies (*Hydrobiosis* and *Pycnocentrodes*), and cranefly (*Aphrophila*)); and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)). Eight of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive', four 'moderately sensitive', and three 'tolerant' taxa, whereas one 'highly sensitive', three 'moderately sensitive', and four 'tolerant' taxa comprised the dominant taxa of the summer, 2010 community. Seven of these nine taxa were dominant in both spring and summer communities (Table 71). The relatively similar seasonal dominances were reflected in the minimal difference (0.1 unit) in seasonal $SQMCI_s$ scores (Tables 156 and 157).

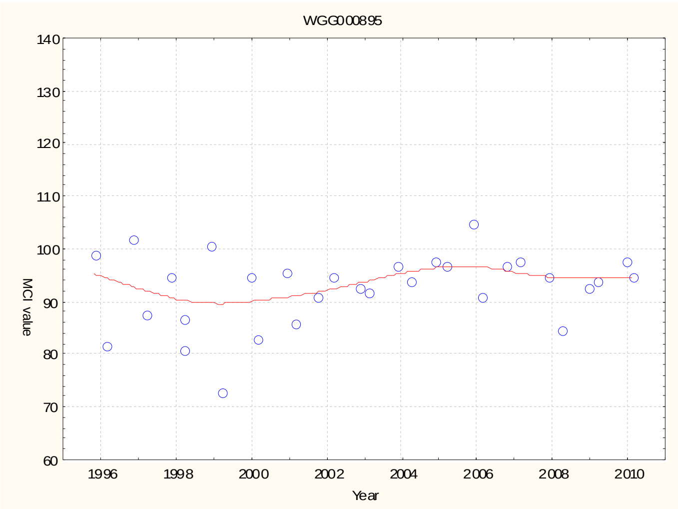
The six taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 41% to 100% of past survey occasions.

3.2.16.5.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 89 (altitude) and 85 (distance) for this site. The historical site median (95) is 6 units higher than the altitude prediction and ten units higher than the predictive distance value. The spring, 2009 survey score (98 units) was 9 units higher than the altitude predictive value and a significant (Stark, 1998) 13 units higher than the predictive distance value while the summer, 2010 score (95 units) was 6 units higher than the predictive altitude value and ten units above the predicted distance value. Of the 31 surveys to date at this site, 13% of MCI scores have been less than 85 units while 74% have been greater than 89 units.

3.2.16.5.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date 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. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 67.



N = 31
Kendall tau = +0.158
p value = 0.212 [>FDR, p = 0.355]
N/S at $p < 0.05$

Figure 67 LOWESS trend plot of MCI data for the SH45 site

A slightly positive trend in MCI scores has been found over the fifteen year period, particularly since 2000 followed by a plateauing in trend since 2005, but this has not been statistically significant. The LOWESS-smoothed range (7 units) of scores has not been ecologically significant. LOWESS-smoothed MCI scores have consistently indicated 'fair' generic river health (Table 1) throughout the period. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain river, river health has remained in the 'better than expected' category, throughout the period, although it approached the 'expected' category during a two year (1998 to 2000) period.

3.2.16.6 Ohawe Beach site (WGG000995)

3.2.16.6.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken in the Waingongoro River at this lower reach site at Ohawe Beach between 1995 and March 2009. These results are summarised in Table 72, together with the results from the current period, and illustrated in Figure 68.

Table 72 Results of previous surveys performed in the Waingongoro River at the Ohawe Beach site, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		February 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000995	28	12-25	18	69-98	87	17	93	20	91

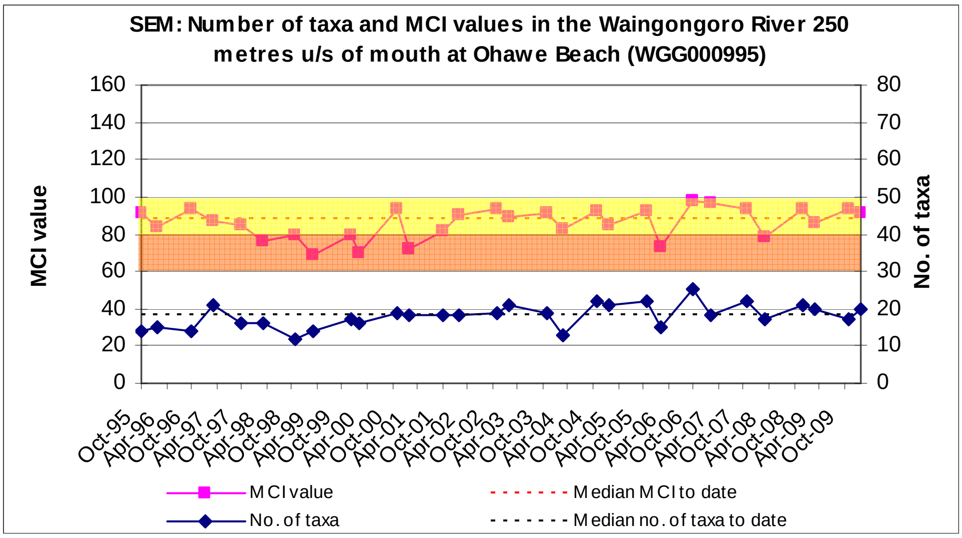


Figure 68 Numbers of taxa and MCI values in the Waingongoro River at the Ohawe Beach site

A wide range of richnesses (12 to 25 taxa) has been found, with a median richness of 18 taxa. During the 2009-2010 period spring (17 taxa) and summer (20 taxa) richnesses were relatively similar and within two taxa of the median richness.

MCI values have had a moderate range (29 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (87 units) has been relatively typical of scores at lower reach sites elsewhere on the ringplain (TRC, 1999 (updated, 2009)). The spring, 2009 (93 units) and summer, 2010 (91 units) scores were relatively similar and also typical for such a site and within 6 units of the historical median. These scores categorised this site as having 'fair' health generically (Table 1) on both occasions and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the lower reaches of a ringplain river. The historical median score (87 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.16.6.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 73.

Table 73 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waingongoro River at the Ohawe Beach site between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	19	68	VA	VA
	Lumbricidae	5	1	4		
MOLLUSCA	*Potamopyrgus*	4	23	82	A	VA
CRUSTACEA	*Paratya*	3	2	7		
EPHEMEROPTERA	*Austroclima*	7	2	7		
	Deleatidium	8	4	14		
COLEOPTERA	Elmidae	6	19	68	A	A
TRICHOPTERA	*Aoteapsyche*	4	27	96	XA	XA
	Costachorema	7	1	4		
	Hydrobiosis	5	3	11		
	Pycnocentrodes	5	21	75	VA	VA
DIPTERA	*Aphrophila*	5	5	18		
	Maoridiamesa	3	21	75	XA	VA
	Orthocladiinae	2	27	96		VA
	Tanytarsini	3	5	18		
	Ephydridae	4	1	4		A
	Austrosimulium	3	4	14		

Prior to the current 2009-2010 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 no ‘highly sensitive’ taxa; two ‘moderately sensitive’ taxa (elmid beetles and stony-cased caddisfly (*Pycnocentrodes*)); and five ‘tolerant’ taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)). Six of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised two ‘moderately sensitive’ taxa and four ‘tolerant’ taxa, whereas two ‘moderately sensitive’ and six ‘tolerant’ taxa comprised the dominant taxa of the summer, 2010 community. Six of these eight taxa were dominant in both spring and summer communities (Table 73) and this was reflected in the minimal difference (0.1 unit) in seasonal $SQMCI_s$ score (Tables 156 and 157).

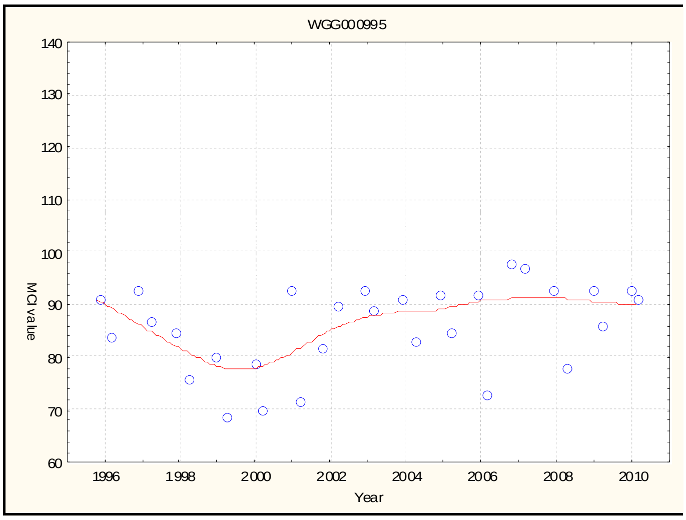
All taxa (five) recorded as very or extrememly abundant during spring and/or summer have characterised this site’s communities on 68% to 96% of past survey occasions.

3.2.16.6.3Predicted 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 85 (altitude) and 85 (distance) for this site. The historical site median (87) is 2 units higher than both the altitude and the distance predictive values. The spring 2009 survey score (93 units) was 8 units higher than both predictive values while the summer score (91 units) was 6 units higher than the predictive altitude and distance values. Of the 30 surveys to date at this site, 37% of MCI scores have been less than 85 units while 57% have been greater than 85 units.

3.2.16.6.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Waingongoro River at Ohawe Beach. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 69.



N = 30
Kendall tau = +0.238
p value = 0.065 [>FDR, p = 0.170]
N/S at $p < 0.05$

Figure 69 LOWESS trend plot of MCI data at the Ohawe Beach site

While there has been a marked trend of MCI scores improvement since 2001, the overall fifteen-year temporal trend has not been statistically significant. However, the range of LOWESS-smoothed scores (14 units) has been ecologically significant, mainly due to the influence of a series of low score (<81 MCI units) between 1998 and 2001.

Smoothed MCI scores were consistently indicative of 'fair' generic river health (Table 1) with the exception of the 1998 to 2001 period when generic health fell to 'poor'. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, river health has improved from 'expected' between 1995 and 2005 to 'better than expected' over the subsequent five years.

3.2.16.7 Discussion

Seasonal MCI values typically decreased between spring and summer at the five sites below the National Park site (which increased by 2 units) by 9, 6, 1, 3, and 2 units respectively in a downstream direction. Seasonal communities shared 75% of the 36 taxa common at the upper site, 65% of 31 taxa at the Opunake Road mid-reach site, 76% of 25 taxa at the Eltham Road mid-reach site, 60% of 25 taxa at the Stuart Road mid-reach site, 54% of 24 taxa at the SH45 lower reach site, and 54% of 24 taxa at the furthest downstream site (Ohawe Beach) in the lower reaches. Seasonal community compositions therefore were generally more variable with increased distance downstream from the National Park.

Community composition varied markedly through the length of the river surveyed. A total of 43 taxa was recorded in spring of which only seven taxa were present at all six sites. These included one 'highly sensitive' taxon, five 'moderately sensitive' taxa, and one 'tolerant' taxon with only the 'moderately sensitive' elmid beetle and 'tolerant' net-building caddisfly (*Aoteapsyche*) abundant at all six sites. A higher total of 52 taxa was found along the river's length by the summer survey of which seven taxa also were present at all six sites. These were very similar to the eight widespread taxa in spring with the addition of one 'moderately sensitive' taxon and loss of the 'highly sensitive' taxon. Only the one 'moderately sensitive' beetle was abundant at all six sites. These dissimilarities in spatial community structure along the length of the Waingongoro River were just as pronounced in spring as in summer.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 33 units in spring and 37 units in summer, over a river distance of 65.9 km. These seasonal falls in MCI scores equated to rates of decline of 0.5 unit/km (spring) and 0.6 unit/km (summer), compared with a predicted rate of 0.7 unit/km for the equivalent length and reach of a National Park-sourced river (Stark and Fowles, 2009). This was typical of the trend of most past summers' seasonal increases in rates of decline. These relatively low rates of decline may be explained in part by the extensive meander pattern unique to this catchment which has a total river length of 76 km from its source to the coast (67 km outside the National Park) compared with the average ringplain stream length of approximately 25 km.

Between the upper and mid-reach site at Eltham Road, the spring (0.7 units/km) and summer (1.0 unit/km) rates of decline were far lower than the predicted rate (1.5 units/km) for the equivalent river reach. For the mid-reach Eltham Road to Ohawe Beach lower reach site, spring (0.4 unit/km) and summer (0.3 unit/km) rates of decline were very similar to the predicted rate of 0.3 unit/km. However, a more marked rate of decline has been recorded between the Eltham Road and Stuart Road mid-reach sites (6.6 km reach) in spring (2.6 units/km) and summer (1.8 unit/km) compared with the predicted rate (0.5 units/km) for the equivalent reach of this river. This is attributable to point source discharges of treated Eltham municipal wastes and, prior to the spring survey, treated industrial (meatworks) wastes within this reach.

Using the long-term median SEM MCI scores for each site (Appendix II), the rates of decline between upper and mid catchment (Eltham Road) and mid catchment (Stuart Road) and lower river sites have been about 1.4 and 0.13 units per km respectively with an overall average rate of decline of 0.7 MCI unit/km over the river's length. Therefore rates of decline over the 2009-2010 period were lower in both spring and summer than have been typical of rates prior to 2009.

3.2.17 Mangawhero Stream

The results found by the 2009-2010 surveys are presented in Table 158 and Table 159 Appendix I for this small stream draining the Ngaere swamp, with a lower sub-catchment (Mangawharawhara Stream) rising on the ringplain but outside of the National Park.

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

3.2.17.1.1Taxa richness and MCI

Twenty-eight surveys have been undertaken in this mid-reach site in the Mangawhero Stream within about 3 km of the Ngaere swamp 1995 and March 2009. These results are summarised in Table 74, together with the results from the current period, and illustrated in Figure 70.

Table 74 Results of previous surveys performed in Mangawhero Stream upstream of Eltham WWTP, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		February 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000380	28	10-23	16	58-79	73	15	85	14	67

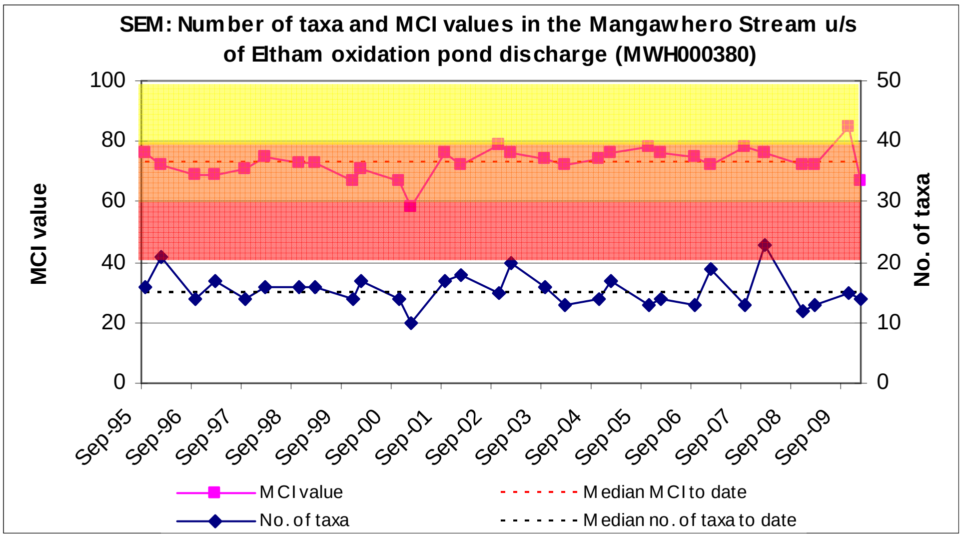


Figure 70 Numbers of taxa and MCI values in the Mangawhero Stream upstream of Eltham WWTP

A moderate range of richnesses (10 to 23 taxa) has been found, with a median richness of 16 taxa (more representative of typical richnesses in small swamp drainage streams where a median richness of 18 taxa has been recorded from 151 previous surveys of 'control' sites at similar altitudes (TRC, 1999 (updated, 2009)). During the 2009-2010 period, spring (15 taxa) and summer (14 taxa) richnesses were very similar and within two taxa of this median richness, at a site where the habitat was predominantly comprised of a hard clay substrate and some instream aquatic vegetation.

MCI values have had a moderate range (21 units) at this site. The median value (73 units) has been typical of similar non-rinplain sites elsewhere in the region however, and the quite different spring, 2009 (85 units) and summer, 2010 (67 units) scores were typical of the range for such a site. There were significantly higher (12 units) in spring and 6 units lower in summer than the historical median and 6 units above the historical maximum in spring. These scores categorised this site as having 'fair' (spring) and 'poor' (summer) health generically (Table 1) and were within 7 to 11 units of the median MCI score (78 units) recorded by 151 previous surveys of similar 'control' sites in small, non ringplain streams in Taranaki (TRC, 1999 (updated, 2009)). The historical median score (73 units) placed this site in the 'poor' category for the generic method of assessment and was 5 units below the median score recorded at similar sites elsewhere.

3.2.17.1.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 75.

Table 75 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Mangawhero Stream upstream of Eltham WWTP between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	1	4		
ANNELIDA	Oligochaeta	1	18	64	VA	
	Lumbricidae	5	1	4		
MOLLUSCA	*Potamopyrgus*	4	2	7		
CRUSTACEA	Ostracoda	1	7	25		A
	Paracalliope	5	24	86	VA	XA
EPHEMEROPTERA	*Austroclima*	7	25	89	VA	VA
TRICHOPTERA	*Aoteapsyche*	4	12	43		
	Hydrobiosis	5	5	18		
	Polyplectropus	6	1	4		
	Oxyethira	2	4	14		
DIPTERA	*Aphrophila*	5	14	50		
	Chironomus	1	2	7		
	Maoridiamesa	3	6	21	A	
	Orthocladiinae	2	28	100	A	A
	Austrosimulium	3	15	54		

Prior to the current 2009-2010 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 upper reaches of a non-ringplain swamp seepage stream.

Predominant taxa have included three 'moderately sensitive' taxa (amphipod (*Paracalliope*), mayfly (*Austroclima*), and cranefly (*Aphrophila*)); and four 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), sandfly (*Austrosimulium*), and orthoclad midges).

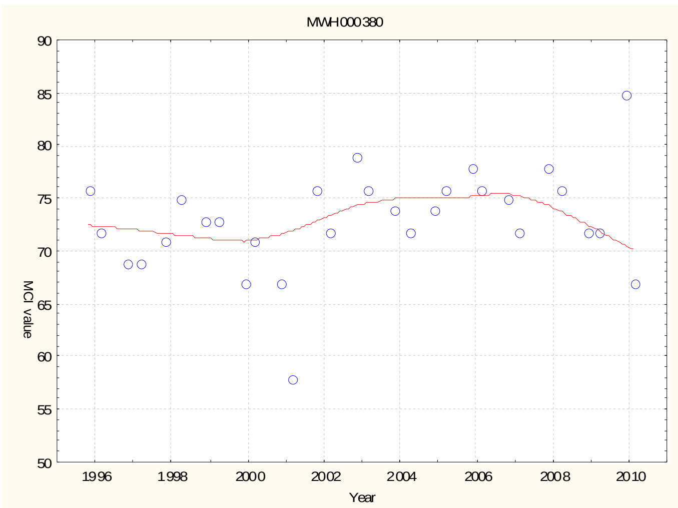
Five of the historically characteristic taxa were dominant in the spring, 2009 community and comprised four of the predominant taxa (above). The summer, 2010 community was characterised by three of the taxa dominant in spring, together with an additional 'tolerant' (ostracod seed shrimps) taxon, three of which previously had been predominantly characteristic of this site's communities (Table 75). An increase in abundance of 'sensitive' amphipods in the summer survey was reflected in the relatively small increase in $SQMCI_s$ scores (0.8 unit) between seasons (Tables 158 and 159). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 64% of 100% of past surveys.

3.2.17.1.3Predicted 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 at an altitude of 200 m asl, toward its upper reaches. Relationships for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), therefore are not applicable in the upper reaches of this type of stream.

3.2.17.1.4Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Mangawhero Stream upstream of the Eltham WWTP discharge. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 71.



N = 30
Kendall tau = +0.217
p value = 0.092 [>FDR, p = 0.209]
N/S at $p < 0.05$ level

Figure 71 LOWESS trend plot of MCI data at site upstream of the Eltham WWTP discharge

A positive but not statistically significant temporal trend in MCI scores has been found over the fifteen year monitoring period at this site with the initial trend of increasing scores having been followed by a recent gradual decline in scores to similar to those recorded early in the programme. The narrow range of LOWESS-smoothed scores (5 units) has not been of ecological significance. LOWESS-smoothed MCI scores consistently have been indicative of 'poor' generic stream health (Table 1) throughout the period but, due to the often weedy, more drain-like nature of this site, the more recently established $SQMCI_s$ may also be an appropriate index to consider in future.

3.2.17.2 Site downstream of the Mangawharawhara Stream confluence (MWH000490)

3.2.17.2.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken at this lower reach site in the Mangawhero Stream between 1995 and March 2009. These results are summarised in Table 76, together with the results from the current period, and illustrated in Figure 72.

Table 76 Results of previous surveys performed in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence, prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000490	28	13-25	19	63-86	77	18	81	23	79

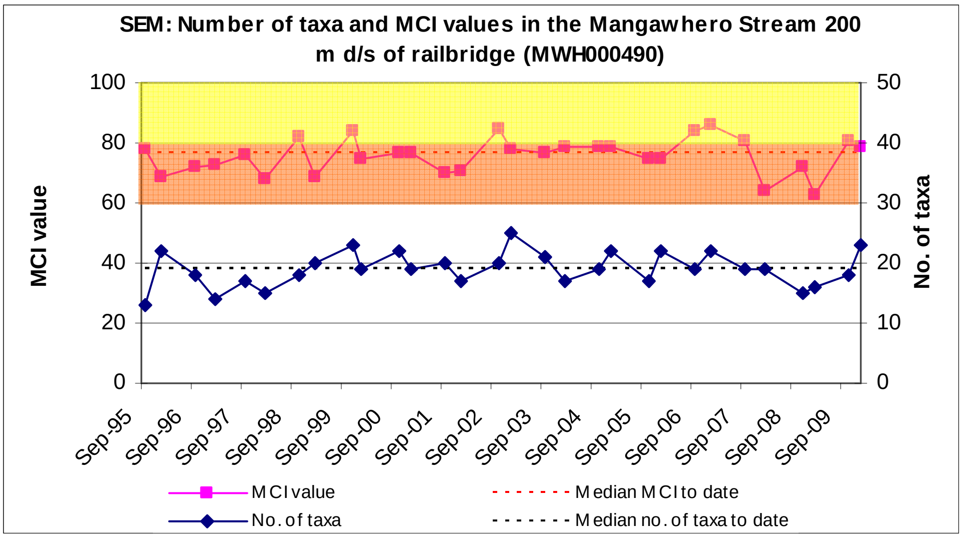


Figure 72 Numbers of taxa and MCI values in the Mangawhero Stream downstream of the railbridge and Mangawharawhara Stream confluence

A moderate range of richnesses (13 to 25 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). During the 2009-2010 period, spring (18 taxa) and summer (23 taxa) richnesses were close to this median richness.

MCI values have had a moderate range (23 units) at this site, more typical of a site in the middle to lower reaches of streams and rivers. However, the median value (77 units) has been lower than typical of lower reach sites elsewhere. The spring, 2009 (81 units) and summer, 2010 (79 units) scores were 2 to 4 units higher than the historical median. These scores categorised this site as having 'fair' to 'poor' health generically (Table 1) in spring and summer respectively and, in terms of predictive relationships (Table 2), 'worse than expected' health for the equivalent reaches of a stream with some ringplain catchment component (Mangawharawhara Stream which rises outside of the National Park) on both of these occasions. The historical median score (77 units) placed this site in the 'poor' and 'worse than expected' categories for generic and predictive methods of assessment respectively. These scores reflected both the more lowland nature of the headwaters of the Mangawhero Stream, but more particularly, the impact of the Eltham municipal wastewater treatment system's discharge on the water quality of the stream.

3.2.17.2.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 77.

Table 77 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence, between 1995 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	28	100	VA	XA
MOLLUSCA	*Physa*	3	2	7		
	Potamopyrgus	4	5	18	A	A
CRUSTACEA	Cladocera	5	3	11		
	Ostracoda	1	24	86	A	XA
	Paracalliope	5	27	96	XA	VA
	Paraleptamphopidae	5	2	7		
EPHEMEROPTERA	*Austroclima*	7	1	4		
	Deleatidium	8	1	4		
COLEOPTERA	Elmidae	6	2	7		
TRICHOPTERA	*Aoteapsyche*	4	15	54	VA	XA
	Hydrobiosis	5	7	25		A
	Oxyethira	2	9	32		
	Pycnocentrodes	5	1	4		
DIPTERA	*Aphrophila*	5	5	18		
	Chironomus	1	2	7		
	Maoridiamesa	3	13	46	A	A
	Orthocladiinae	2	26	93		A
	Tanypodinae	5	1	4		
	Tanytarsini	3	1	4		
	Muscidae	3	1	4		
	Austrosimulium	3	13	46		

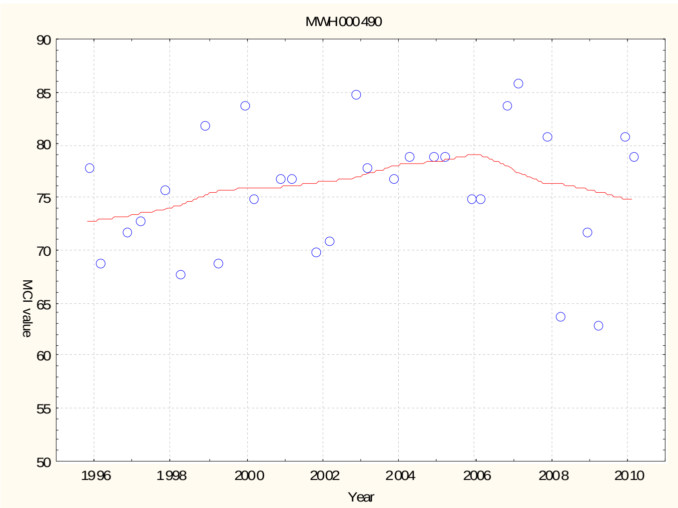
Prior to the current 2009-2010 period, 22 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', nine 'moderately sensitive', and twelve 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa than might be expected in the mid reaches of a small stream with a ringplain component. Predominant taxa have included one 'moderately sensitive' taxon (amphipod (*Paracalliope*)) and seven 'tolerant' taxa (oligochaete worms, ostracod seed shrimps, net-building caddisfly (*Aoteapsyche*), algal-piercing caddisfly (*Oxyethira*), and midges (orthoclads and *Maoridiamesa*), and sandfly (*Austrosimulium*)). Five of these predominant taxa were dominant in the spring, 2009 community together with one of the other historically characteristic taxa. The summer, 2010 community was characterised by the same taxa dominant in spring, together with two additional taxa; all of which previously had been characteristic of this site's communities (Table 77). Despite seasonal similarities in characteristic taxa, increased summer abundances within three of the 'tolerant' taxa was reflected in the relatively large difference (1.9 units) in $SQMCI_s$ scores (Tables 158 and 159). All taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 54% to 100 % of the past surveys.

3.2.17.2.3 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. A relationship for ringplain streams and rivers developed between MCI and altitude (Stark and Fowles, 2009) predicts a MCI value of 104 units for this site. The historical site median (77 units) was very significantly lower than this altitude prediction while the spring, 2009 (81 units) and summer, 2010 (79 units) scores were also well below this predictive value by 23 and 25 units respectively. Of the 30 surveys to date at this river site, all MCI scores have been less than 104 units.

3.2.17.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years 1995-2010) of SEM results collected to date 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. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 73.



N = 30
Kendall tau = +0.174
p value = 0.178 [>FDR, p = 0.319]
N/S at $p < 0.05$

Figure 73 LOWESS trend plot of MCI data at the site downstream of the Mangawharawhara Stream confluence

A moderate, but not statistically significant temporal 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 LOWESS-smoothed scores range (6 units) has no ecological significance over this fifteen year period and scores have trended downwards more recently, since a steady improvement between 1995 and 2006.

The MCI scores were generally indicative of 'poor' generic stream health (Table 1) with sporadic incursions into the 'fair' health category, although the LOWESS-smoothed scores have remained in the 'poor' category throughout the period. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain stream (recognising the partial ringplain component of this catchment and the position of the site in the lower reach of this small stream prior to joining the mid-reaches of a larger ringplain river), stream health fell in the 'worse than expected' category throughout the entire fifteen year period.

3.2.17.3 Discussion

Seasonal MCI values typically deteriorated markedly between spring and summer at the upper reach (upstream of the Eltham WWTP) site by 18 units, whereas a less than typical and insignificant decrease (2 units) was found at the lower site (downstream of the Mangawharawhara Stream confluence) where impacts of the WWTP discharge significantly impacted water quality. Seasonal communities at the upper reach site shared 11 common taxa (61% of the 18 taxa found in 2009-2010) compared with 14 shared common taxa (52% of the 27 taxa found in 2009-2010) at the lower site, a typically slightly more pronounced seasonal change in community structure at the lower of the two sites. The two sites shared 13 common taxa (65% of the 20 taxa) in spring and 12 common taxa (48% of 25 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and summer and typically more so in summer, as might be expected given the significantly different physical and physicochemical habitats at these two sites.

MCI scores atypically fell in a downstream direction by only 4 units in spring and increased in summer (by 12 units), over a stream distance of 16.5 km between the upper and lower sites of this stream principally as a result of the impacts of the Eltham WWTP discharge on the stream and the variability in habitat between the two sites.

3.2.18 Huatoki Stream

The results of spring (2009) and summer (2009-2010) surveys are summarised in Table 160 and Table 161, Appendix I.

3.2.18.1 Hadley Drive site (HTK000350)

3.2.18.1.1 Taxa richness and MCI

Twenty-six surveys have been undertaken, between 1996 and March 2009, at this lower mid-reach, unshaded site, draining open developed farmland, on the outskirts of New Plymouth city. These results are summarised in Table 78, together with the results from the current period, and illustrated in Figure 74.

Table 78 Results of previous surveys performed in the Huatoki Stream at Hadley Drive prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1996 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000350	26	22-31	26	79-105	94	26	100	23	98

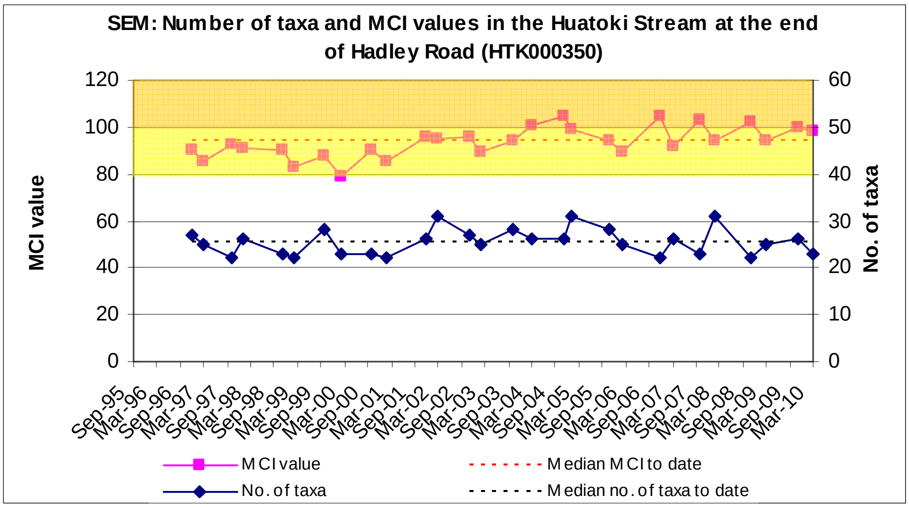


Figure 74 Numbers of taxa and MCI values in the Huatoki Stream at the end of Hadley Drive

A moderate range of richnesses (22 to 31 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 the National Park boundary. During the 2009-2010 period spring (26 taxa) and summer (23 taxa) richnesses were within three taxa of this median richness coincident with extensive periphyton layers on the predominantly stony-bouldery substrate of this unshaded site.

MCI values have had a moderate range (26 units) at this site, typical of mid to lower reach sites on the ringplain. The historical median value (94 units) also has been typical of mid-reach sites rising outside the National Park elsewhere on the ringplain, and the spring, 2009 (100 units) and summer, 2010 (98 units) scores were 6 units and 4 units above the historical median respectively. They categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health for the mid-reaches of a ringplain stream on these occasions. The historical median score (94 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.18.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 79.

Table 79 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Huatoki Stream at Hadley Drive, between 1996 and March 2009 [26 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	3	12		
ANNELIDA	Oligochaeta	1	17	65	A	
MOLLUSCA	*Latia*	5	1	4		
	Potamopyrgus	4	19	73		A
CRUSTACEA	*Paracalliope*	5	6	23		
EPHEMEROPTERA	*Austroclima*	7	4	15	A	
	Coloburiscus	7	12	46		VA
	Nesameletus	9	3	12	A	VA
	Zephlebia group	7	15	58		VA
PLECOPTERA	*Zelandobius*	5	6	23	A	
	Zelandoperla	8	1	4		
COLEOPTERA	Elmidae	6	4	15	A	VA
MEGALOPTERA	*Archichauliodes*	7	0	0		A
TRICHOPTERA	*Aoteapsyche*	4	25	96	VA	VA
	Costachorema	7	16	62		
	Hydrobiosis	5	18	69		A
	Neurochorema	6	2	8		
	Oxyethira	2	4	15		
	Pycnocentrodes	5	3	12	A	
DIPTERA	*Aphrophila*	5	15	58	A	
	Maoridiamesa	3	14	54	A	
	Orthocladiinae	2	26	100	VA	A
	Tanytarsini	3	11	42		VA
	Empididae	3	1	4		
	Muscidae	3	5	19		
	Austrosimulium	3	12	46		

Prior to the current 2009-2010 period 26 taxa had characterised the community at this site on occasions. These have comprised only two 'highly sensitive', 13 'moderately sensitive' and 11 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower mid-reaches of a ringplain stream rising outside the National Park.

Predominant taxa have included five 'moderately sensitive' taxa (mayflies (*Coloburiscus* and *Zephlebia* group), free-living caddisflies (*Hydrobiosis* and *Costachorema*), and cranefly (*Aphrophila*)) and seven 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), midges (orthoclads, tanytarsids, and *Maoridiamesa*), and sandfly (*Austrosimulium*)).

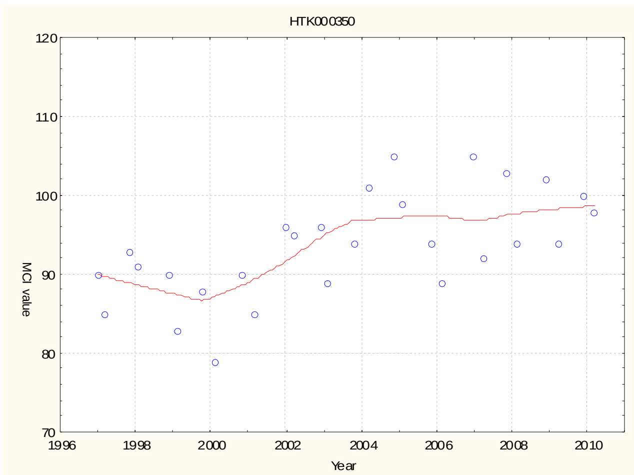
Ten of the historically characteristic taxa were dominant in the spring, 2009 community and comprised five of the predominant taxa (above) together with one 'highly sensitive' and four 'moderately sensitive' taxa. The summer, 2010 community was characterised by four of the taxa dominant in spring, together with an additional three 'moderately sensitive' and two 'tolerant' taxa, all of which previously had been characteristic of this site's communities, and one 'moderately sensitive' taxon (dobsonfly, *Archichauliodes*) which had not been recorded as dominant previously at this site (Table 79). Increased summer abundances within several 'sensitive' dominant taxa were reflected in the difference in seasonal $SQMCI_s$ scores of 1.5 units (Table 160 and 161). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 12% to 100% of past surveys.

3.2.18.1.3 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. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 91 units for this site. The historical site median (94 units) is only 3 units above this altitude prediction while the spring survey score (100 units) and the summer score (98 units) were higher (by 7 to 9 units) than the predictive value. Of the 28 surveys to date at this site, 38% of MCI scores have been less than 91 units, indicating that the current spring and summer MCI scores were more typical of historical conditions.

3.2.18.1.4 Temporal trends in 1996 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fourteen years of SEM results collected to date 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. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 75.



N = 28
Kendall tau = +0.417
p level = 0.002 [>FDR, p = 0.011]
Significant at $p < 0.05$
and after FDR application

Figure 75 LOWESS trend plot of MCI data at the Hadley Drive site

A relatively strong temporal improvement ($p < 0.05$) in MCI scores, particularly between 2000 and 2005, has been illustrated at this site on the outskirts of New Plymouth. The overall trend has also been statistically significant after FDR application and the LOWESS-smoothed range of MCI scores (13 units) has some ecological significance and 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 urban New Plymouth.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) throughout the period but approaching 'good' health more recently. In terms of predictive relationships (Table 2) for a site in the lower mid-reaches of a ringplain stream, health has remained in the 'expected' category over the fourteen year period although it bordered the 'worse than expected' category prior to 2000 and most recently approached the 'better than expected' category (Figure 75).

3.2.18.2 Huatoki Domain site (HTK000425)

3.2.18.2.1 Taxa richness and MCI

Twenty-six surveys have been undertaken at this lower reach site in the Huatoki Stream toward the downstream boundary of the Huatoki Domain between 1996 and March 2009. These results are summarised in Table 80, together with the results from the current period, and illustrated in Figure 76.

Table 80 Results of previous surveys performed at Huatoki Stream in Huatoki Domain, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1996 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000425	26	17-32	26	91-115	102	25	105	26	104

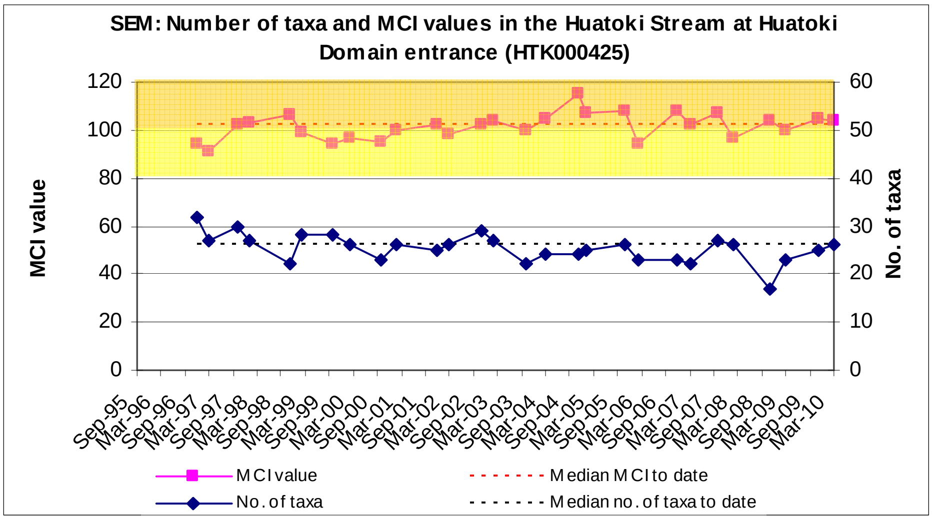


Figure 76 Numbers of taxa and MCI values in the Huatoki Stream at the Huatoki Domain

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 2009-2010 period spring (25 taxa) and summer (26 taxa) richnesses were similar and slightly lower than or equivalent to this median richness.

MCI values have had a moderately wide range (24 units) at this site. The median value (102 units) has been higher than typical of lower reach sites elsewhere on the ringplain however. The spring, 2009 (105 units) and summer, 2010 (104 units) scores were also higher than typical for such a site; but insignificantly 3 and 2 units above the historical median respectively. These scores categorised this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health for the lower reaches of a ringplain stream on both these occasions coincident with the extensive riparian cover provided by the Huatoki Domain. The historical median score (102 units) placed this site in the 'good' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.18.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 81.

Table 81 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Huatoki Stream at Huatoki Domain, between 1996 and February 2009 [26 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	3	12		
ANNELIDA	Oligochaeta	1	23	88	A	A
MOLLUSCA	*Latia*	5	15	58		
	Potamopyrgus	4	22	85	VA	A
CRUSTACEA	*Paracalliope*	5	3	12		
EPHEMEROPTERA	*Austroclima*	7	2	8	A	
	Coloburiscus	7	22	85		VA
	Mauiulus	5	1	4		
	Zephlebia group	7	25	96	A	VA
PLECOPTERA	*Zelandobius*	5	13	50	VA	
COLEOPTERA	Elmidae	6	15	58	VA	VA
	Ptilodactylidae	8	3	12		
MEGALOPTERA	*Archichauliodes*	7	9	35		A
TRICHOPTERA	*Aoteapsyche*	4	25	96	A	VA
	Costachorema	7	1	4		
	Hydrobiosis	5	6	23		
	Pycnocentrodes	5	16	62	A	
DIPTERA	*Aphrophila*	5	1	4		
	Orthocladiinae	2	8	31		
	Austrosimulium	3	25	96	A	VA
	Tanyderidae	4	1	4		

Prior to the current 2009-2010 period, 21 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', 13 'moderately sensitive', and seven '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 seven 'moderately sensitive' taxa (luminescent limpet (*Latia*), mayflies (*Zephlebia* group and *Coloburiscus*), stonefly (*Zelandobius*), elmid beetles, dobsonfly (*Archichauliodes*), and stony-cased caddisfly (*Pycnocentrodes*) and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), orthoclad midges, and sandfly (*Austrosimulium*)).

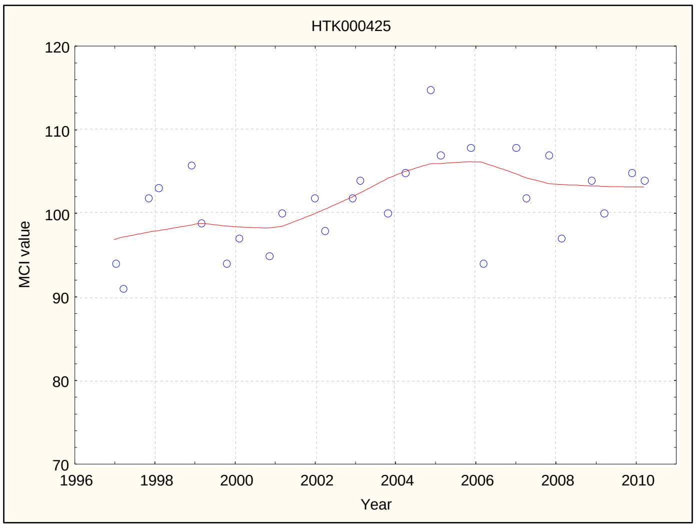
Nine of the historically characteristic taxa were dominant in the spring, 2009 community and comprised eight of the predominant taxa (above) together with one 'moderately sensitive' mayfly taxon. The summer, 2010 community was characterised by six of the taxa dominant in spring, together with an additional two 'moderately sensitive' taxa, both of which previously had been characteristic of this site's communities (Table 81). The relative similarity in seasonal dominant taxa was reflected in the small difference in $SQMCI_s$ scores of 0.3 unit (Tables 160 and 161). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 50% to 96% of past surveys.

3.2.18.2.3 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. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 87 units for this site. The historical site median (102 units) is well above this altitude prediction coincident with the extensive riparian vegetation cover of the Huatoki Domain and both the spring survey score (105 units) and the summer score (104 units) were significantly higher (Stark, 1998) than the predictive value. Of the 28 surveys to date at this site, no MCI scores have been less than 87 units, indicating that the current spring and summer MCI scores were typical of historical conditions.

3.2.18.2.4 Temporal trends in 1996 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fourteen years of SEM results collected to date from the site in the Huatoki Stream at Huatoki Domain. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 77.



N = 28
Kendall tau = +0.323
p level = 0.016 [>FDR, p = 0.055]
Significant at p< 0.05;
N/S after FDR application

Figure 77 LOWESS trend plot of MCI data for the Huatoki Domain site

A similar temporal trend of a marked improvement in MCI scores to that found at the upstream site (at Hadley Drive) was identified at this site in the Domain although scores have plateaued with a small decrease since 2006. Although this trend was not statistically significant after FDR application and the LOWESS-smoothed range of scores (9 units) has no ecological significance, the trend may have been related to the upstream catchment activities noted above (Section 3.2.18.1.4).

The smoothed MCI scores which indicated 'fair' generic stream health (Table 1) earlier in the monitoring period, have improved to 'good' stream health consistently since 2002. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, health has remained 'better than expected' over the majority of the period, briefly approaching the 'well above expected' category (in 2005-2006) further indication of the value of the extensive riparian cover provided by the Huatoki Domain.

3.2.18.3 Site near coast (HTK000745)

3.2.18.3.1Taxa richness and MCI

Twenty-six surveys have been undertaken at this lower reach site in the Huatoki Stream between 1996 and March 2009. These results are summarised in Table 82, together with the results from the current period, and illustrated in Figure 78.

Table 82 Results of previous surveys performed in Huatoki Stream at the site near the coast, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1996 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000745	26	14-27	22	69-99	86	20	85	17	88

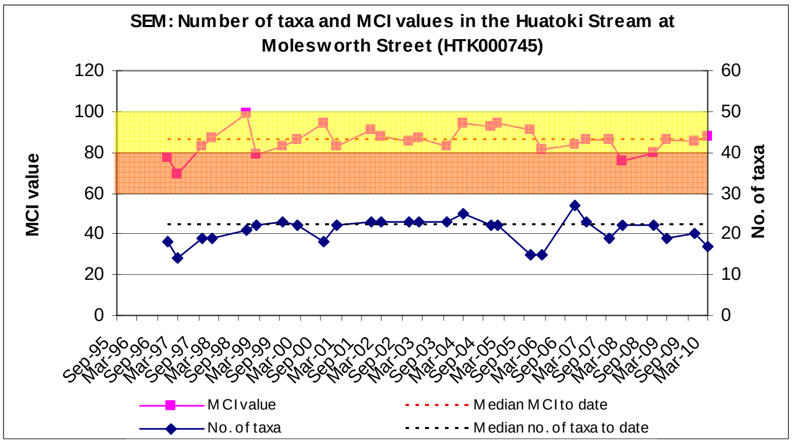


Figure 78 Numbers of taxa and MCI values in the Huatoki Stream at Molesworth Street (near coast)

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 2009-2010 period spring (20 taxa) and summer (17 taxa) richnesses were relatively similar and slightly lower than this median richness.

MCI values have had a relatively wide range (30 units) at this site. The median value (86 units) has been typical of lower reach sites elsewhere on the ringplain however, and the spring, 2009 (85 units) and summer, 2010 (88 units) scores have also been typical for such a site and within two units of the historical median. These scores categorised this site as having 'fair' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health for the lower reaches of a ringplain stream on both these occasions. The historical median score (86 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.18.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 83.

Table 83 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Huatoki Stream at the site near the coast, between 1996 and March 2009 [26 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	1	4		
ANNELIDA	Oligochaeta	1	26	100	XA	XA
MOLLUSCA	*Ferrissia*	3	1	4		
	Latia	5	3	12		
	Potamopyrgus	4	26	100	VA	VA
CRUSTACEA	*Paratya*	3	2	8		
EPHEMEROPTERA	*Coloburiscus*	7	4	15		
	Zephlebia group	7	5	19		
PLECOPTERA	*Zelandobius*	5	3	12		
COLEOPTERA	Elmidae	6	10	38	A	VA
TRICHOPTERA	*Aoteapsyche*	4	3	12		
	Oxyethira	2	1	4		
	Pycnocentrodes	5	8	31		
	Triplectides	5	2	8		
DIPTERA	*Aphrophila*	5	1	4		
	Orthocladiinae	2	13	50		A
	Empididae	3	2	8		
	Austrosimulium	3	1	4		
	Tanyderidae	4	4	15		

Prior to the current 2009-2010 period, 19 taxa had characterised the community at this site on occasions. These have comprised no 'highly sensitive', eight 'moderately sensitive', and 11 '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 two 'moderately sensitive' taxa (elmid beetles and stony-cased caddisfly (*Pycnocentrodes*); and three 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges).

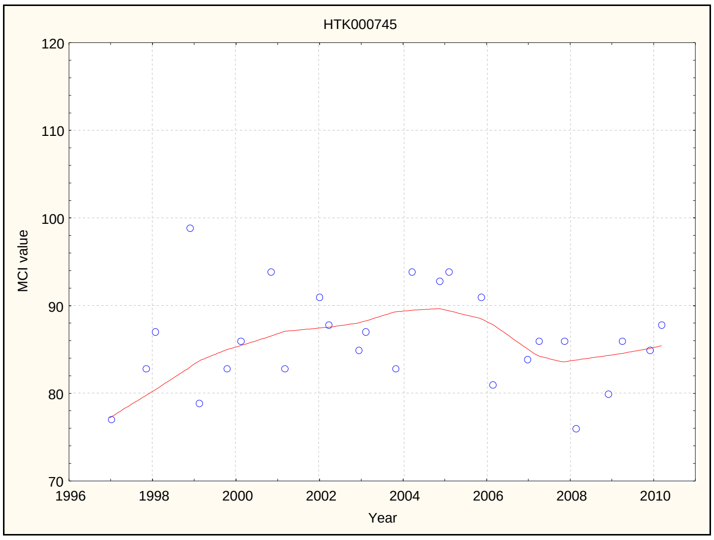
Three of the historically characteristic taxa were dominant in the spring, 2009 community and comprised three of the predominant taxa (above), while the summer, 2010 community was characterised by the same three taxa dominant in spring, together with an additional 'tolerant' (midge) taxa, all of which previously had been characteristic of this site's communities (Table 83). The relative similarity in seasonal dominant taxa was reflected in the small difference in $SQMCI_s$ scores of 0.4 unit (Table 160 and 161). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 38% to 100% of past surveys.

3.2.18.3.3 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. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 85 units for this site. The historical site median (86 units) is only one unit above this altitude prediction while the spring score (85 units) and the summer score (88 units) were also very similar to the predictive value. Of the 28 surveys to date at this site, 39% of MCI scores have been less than 85 units, indicating that the current spring and summer MCI scores were relatively typical of historical conditions.

3.2.18.3.4Temporal trends in 1996 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fourteen years of SEM results collected to date from the site, in the Huatoki Stream near the coast. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 79.



N = 28
Kendall tau = +0.068
p level = 0.612 [>FDR, p = 0.716]
N/S at p< 0.05

Figure 79 LOWESS trend plot of MCI data for the site near the coast

A trend of steady improvement in MCI scores has occurred at this urbanised site until 2005 after which scores have trended downward resulting in an overall weakly positive and statistically non-significant trend for the fourteen year monitoring period. However, the range of LOWESS-smoothed scores (13 units) has some ecological significance probably related in part to those activities noted for the two sites further upstream in the Huatoki catchment (see above).

Smoothed MCI scores indicative of 'fair' generic stream health (Table 1) have been recorded for all but the first year of the monitoring programme (Figure 79) and, in terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, health improved from 'expected' approaching 'better than expected' (for a brief two year period) before trending downward in the 'expected' category since 2006.

3.2.18.4 Discussion

Seasonal MCI values typically decreased between spring and summer at two sites (Hadley Drive and Huatoki Domain) but only by 2 and 1 units respectively while at the site near the coast a typical summer increase in MCI score (3 units) was recorded. Seasonal communities shared 75% of the 28 taxa common at the mid-reach site, 70%

of 30 taxa at Huatoki Domain, and 54% of 24 taxa at the furthest downstream site in the lower reaches near the coast indicative of increasing dissimilarities in seasonal community composition in a downstream direction.

Community composition indicated some improvement at the Domain site where proportionately more higher scoring taxa were recorded. Further downstream, near the mouth, urbanisation and habitat modification coincided with a lower community richness and change in community composition. This site's faunal community composition was characterised by an increase in the 'tolerant' taxa proportion of the community.

MCI score increased by 5 units in spring and 6 units in summer between the open farmland site (Hadley Drive) and the Huatoki Domain site, coincident with the improved habitat provided by the riparian vegetation cover in the domain, and more typical of increases recorded by most past surveys. MCI score fell significantly by 20 units (spring) and 16 units (summer) through the city between the Domain and the coast, despite a change in elevation of only 25 m, representing a rate of MCI decrease of 5.1 and 4.1 units/km respectively, well above the rate expected through the mid to lower reaches of Taranaki ringplain rivers and streams sourced outside of the National Park (TRC, 1999). This MCI rate of decrease was amplified by the presence of the improved habitat within the Huatoki Domain. There were decreases in MCI between the open farmland site and the coast of 15 units (spring) and 10 units (summer) coincident with the impacts of urbanisation on the stream's macroinvertebrate fauna.

Using the long-term median SEM MCI scores for each site (Appendix II), the rate of decline between mid-reach site and lower reach site near the coast has been 2.1 MCI units/km over the surveyed length. Therefore rates of MCI decline over the 2009-2010 period were higher in both spring and summer than typical rates for the 1995 to 2009 period.

Community composition varied markedly through the mid reach to lower reach length of the stream surveyed. A total of 38 taxa was recorded in spring of which only 11 taxa were present at all three sites. These included no 'highly sensitive', six 'moderately sensitive' and five 'tolerant' taxa with only the one 'moderately sensitive' taxon (elmid beetles) and one 'tolerant' taxon (oligochaete worms) abundant at all three sites. A slightly lower total of 34 taxa was found along the stream's surveyed length by the summer survey of which ten taxa were present at all three sites. These were very similar to the eleven widespread taxa in spring with the loss of one 'moderately sensitive'taxon. Only two taxa were abundant at all three sites in summer; 'tolerant' snail (*Potamopyrgus*) and 'moderately sensitive' elmid beetles. Dissimilarities in spatial community structure along the surveyed length (mid to lower reaches) of the Huatoki Stream were just as pronounced in spring as in summer.

3.2.19 Kaupokonui River

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, 2009 survey are presented in Table 162 and the summer, 2009-2010 survey in Table 163, Appendix I.

3.2.19.1 Opunake Road site (KPK000250)

3.2.19.1.1Taxa richness and MCI

Twenty-one surveys have been undertaken in the Kaupokohui River at this upper mid-reach site at Opunake Road (approximately 3.3 km downstream of the National Park) between 1999 and February 2009. These results are summarised in Table 84, together with the results from the current period, and illustrated in Figure 80.

Table 84 Results of previous surveys performed in the Kaupokonui River at Opunake Road, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1996 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000250	21	20-36	27	125-138	129	27	127	27	134

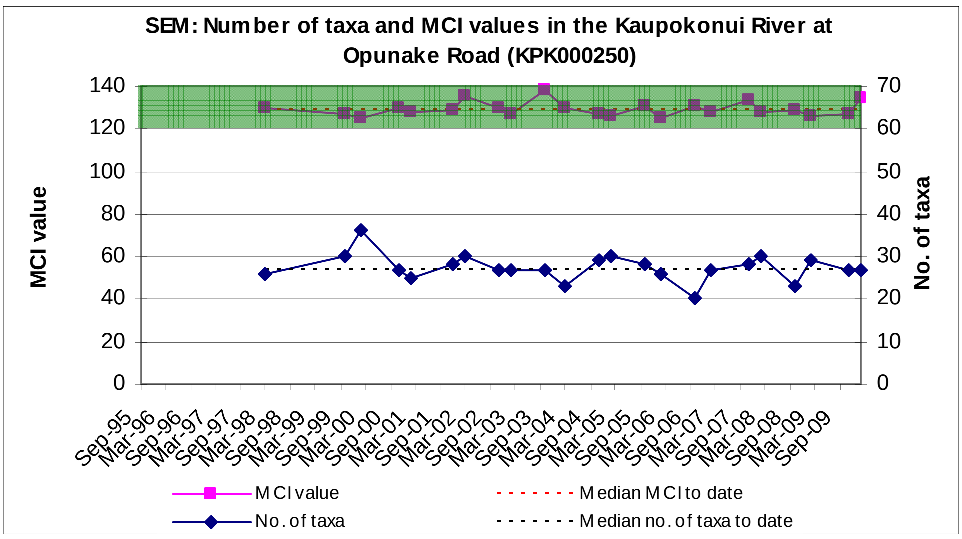


Figure 80 Numbers of taxa and MCI values in the Kaupokonui River at Opunake Road

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 2009-2010 period spring (27 taxa) and summer (27 taxa) richnesses were identical and slightly below median taxa number in both seasons when substrate periphyton cover remained minimal on both occasions.

MCI values have had a relatively narrow range (13 units) at this site, more typical of sites in the upper reaches of ringplain rivers. The median value (129 units) has been higher than typical of mid-reach sites elsewhere on the ringplain however, with the spring, 2009 (127 units) and summer, 2010 (134 units) scores above those typical for such a site and within 5 units of the historical median. These scores categorised this site as having 'very good' (spring) and 'very good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'well above expected' health on both occasions for the mid reaches of a ringplain river. The historical median score (129 units) placed this site in the 'very good' and 'well above expected' categories for generic and predictive methods of assessment respectively.

3.2.19.1.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 85.

Table 85 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kaupokonui River at Opunake Road between 1995 and February 2009 [21 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	2	10		
EPHEMEROPTERA	*Austroclima*	7	2	10		
	Coloburiscus	7	19	90	A	A
	Deleatidium	8	21	100	XA	VA
	Nesameletus	9	11	52		
PLECOPTERA	*Acroperla*	5	1	5		
	Megaleptoperla	9	14	67	A	A
	Zelandoperla	8	19	90	A	VA
COLEOPTERA	Elmidae	6	21	100	A	VA
	Hydraenidae	8	3	14		
MEGALOPTERA	*Archichauliodes*	7	6	29		
TRICHOPTERA	*Aoteapsyche*	4	18	86		A
	Costachorema	7	5	24		
	Hydrobiosis	5	4	19		
	Beraeoptera	8	15	71	A	
	Helicopsyche	10	3	14		
	Olinga	9	12	57	A	A
	Pycnocentrodes	5	11	52		
DIPTERA	*Aphrophila*	5	19	90	A	A
	Eriopterini	5	6	29		
	Maoridiamesa	3	6	29	A	
	Orthocladiinae	2	7	33		

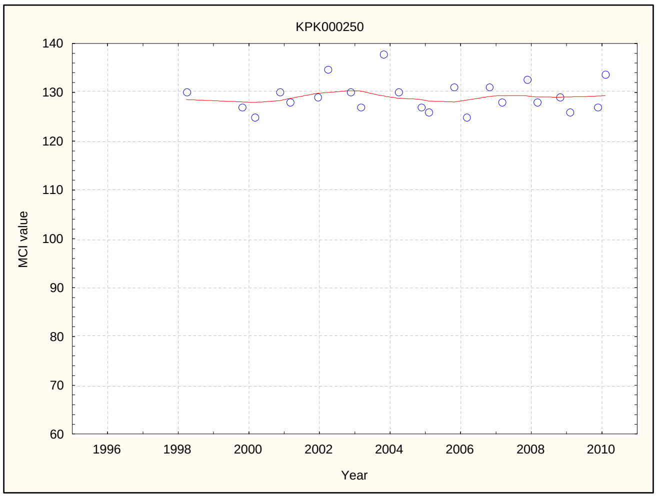
Prior to the current 2009-2010 period, 22 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', ten 'moderately sensitive', and four 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected in the upper mid-reaches of a ringplain stream. Predominant taxa have included six 'highly sensitive' taxa (mayflies (*Deleatidium* on every sampling occasion, and *Nesameletus*), stoneflies (*Megaleptoperla* and *Zelandoperla*), and cased caddisflies (*Beraeoptera* and *Olinga*)); four 'moderately sensitive' taxa (mayfly (*Austroclima*), elmid beetles, stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)); and two 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*) and orthoclad midges). Nine of these taxa were dominant in the spring, 2009 community. These were comprised of five 'highly sensitive', three 'moderately sensitive', and one 'tolerant' taxa. Seven of these were again dominant in the summer, 2010 community when one fewer 'highly sensitive' taxon was dominant. Despite the slight decrease in number of dominant taxa in the summer community, the numerical dominance by 'highly sensitive' taxa in both seasons was reflected in the relative similarity in seasonal $SQMCI_s$ values which differed by only 0.5 unit (Tables 162 and 163). All taxa recorded as very or extremely abundant during spring and/or summer had characterized this site's communties on 90% to 100% of past surveys. Two of the taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on every past survey occasion.

3.2.19.1.3Predicted 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 123 (altitude) and 118 (distance) for this site. The historical site median (129) is 6 units higher than the altitude prediction and a significant (Stark, 1998) 11 units higher than the distance predictive value. The spring, 2009 survey score (127 units) was not significantly higher than both predictive values, whereas the summer, 2010 score (134 units) was significantly higher than both predictive values by 11 to 16 units. Of the 23 surveys to date at this site, no MCI scores have been less than 118 units while all scores have been greater than 123 units, further indicative of the better than predicted health of the river at this site.

3.2.19.1.4Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the eleven years of SEM results collected to date from the site in the Kaupokonui River at Opunake Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 81.



N = 23
Kendall tau = +0.016
p level = 0.913 [>FDR, p = 0.949]
N/S at p< 0.05

Figure 81 LOWESS trend plot of MCI ata at the Opunake Road site

No statistically significant temporal trend in MCI scores was found at this site in the upper mid-reaches of the river over the eleven year monitoring period. The LOWESS-smoothed range of scores (3 units) was extremely narrow and not ecologically significant. Smoothed MCI scores were continuously indicative of 'very good' generic river health (Table 1), while in terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain river, health has been 'well above expected' for the entire period.

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

3.2.19.2.1Taxa richness and MCI

Twenty-four surveys have been undertaken in the Kapokunui River at this mid-reach site at the site upstream of the Kaponga oxidation ponds system between 1995 and February 2009. These results are summarised in Table 86, together with the results from the current period, and illustrated in Figure 86.

Table 86 Results of previous surveys performed in the Kaupokonui River at the site upstream of the Kaponga oxidation ponds system prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1996 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000500	24	21-33	26	98-126	114	26	126	25	120

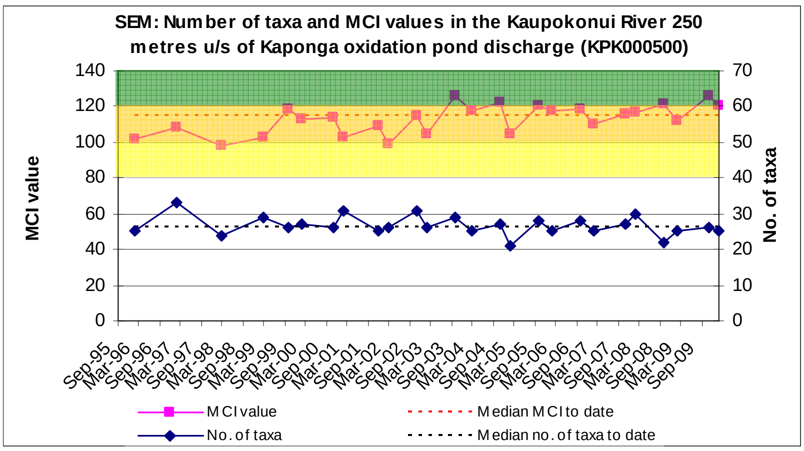


Figure 82 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kaponga oxidation pond system

A moderate range of richnesses (21 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 2009-2010 period, spring (26 taxa) and summer (25 taxa) richnesses were very similar and almost identical to the median taxa number.

MCI values have had a moderate range (28 units) at this site, typical of sites in the mid-reaches of ringplain rivers. The median value (114 units) has been slightly higher than typical of mid-reach sites elsewhere on the ringplain with the spring, 2009 (126 units) and summer, 2010 (120 units) scores above those typical for such a site and higher than the historical median by 6 to 12 units. These scores categorised this site as having 'very good' (spring) and 'very good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'well above expected' and 'better than expected' health in spring and summer respectively for the mid-reaches of a ringplain river. The historical median score (114 units) placed this site in the 'good' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.19.2.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 87.

Table 87 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kaupokonui River upstream of the Kaponga oxidation ponds system between 1995 and February 2009 [24 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	2	8		
ANNELIDA	Oligochaeta	1	6	25		
EPHEMEROPTERA	*Austroclima*	7	1	4		
	Coloburiscus	7	23	96	XA	XA
	Deleatidium	8	19	79	XA	XA
	Nesameletus	9	7	29	A	VA
PLECOPTERA	*Megaleptoperla*	9	1	4		
	Zelandoperla	8	5	21	A	
COLEOPTERA	Elmidae	6	21	88	A	VA
MEGALOPTERA	*Archichauliodes*	7	13	54		A
TRICHOPTERA	*Aoteapsyche*	4	20	83	A	VA
	Costachorema	7	17	71		
	Hydrobiosis	5	8	33		
	Beraeoptera	8	8	33	A	A
	Olinga	9	2	8		A
	Oxyethira	2	1	4		
	Pycnocentrodes	5	10	42	VA	VA
DIPTERA	*Aphrophila*	5	23	96	VA	A
	Eriopterini	5	4	17		
	Maoridiamesa	3	19	79	VA	
	Orthocladiinae	2	18	75	VA	
	Tanytarsini	3	5	21		
	Empididae	3	1	4		
	Muscidae	3	3	13		
	Austrosimulium	3	1	4		

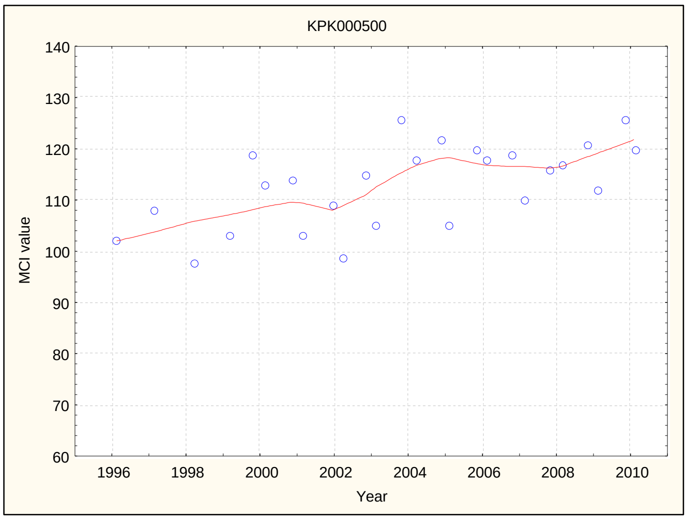
Prior to the current 2009-2010 period, 25 taxa had characterised the community at this site on occasions. These have comprised six 'highly sensitive', nine 'moderately sensitive', and ten 'tolerant' taxa i.e. a majority of 'sensitive' taxa but a small downstream increase in 'tolerant' taxa as would be expected in the mid-reaches of a ringplain river. Predominant taxa have included two 'highly sensitive' taxa (mayfly (*Deleatidium*) and flare-cased caddisflies (*Beraeoptera*)); seven 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), stony-cased caddisfly (*Pycnocentrodes*), free-living caddisflies (*Costachorema* and *Hydrobiosis*), and cranefly (*Aphrophila*)); and three 'tolerant' taxa (free-living caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)). Eleven of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised four 'highly sensitive' taxa, four 'moderately sensitive' taxa, and three 'tolerant' taxa, whereas three 'highly sensitive', five 'moderately sensitive', and one 'tolerant' taxa comprised the dominant taxa of the summer community. Eight of these thirteen taxa were dominant in both spring and summer communities (Table 87). Despite relatively similar seasonal dominances, there was a small increase (0.5 unit) in $SQMCI_s$ scores between spring and summer principally due to the absence of one 'tolerant' taxon and the increased abundance of one of the 'highly sensitive' taxa in summer (Tables 162 and 163). The nine taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 29% to 96% of past survey occasions.

3.2.19.2.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 111 (altitude) and 107 (distance) for this site. The historical site median (114) is 3 units higher than the altitude prediction and 7 units higher than the distance predictive value. The spring, 2009 survey score (126 units) was significantly 15 to 19 units above predictive values and the summer, 2010 score (120 units) was 9 units above the predictive altitude value and a significant 13 units above the predictive distance value. Of the 26 surveys to date at this site, 27% of MCI scores have been less than 107 units while 62% have been greater than 111 units.

3.2.19.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Kaupokonui River upstream of the Kaponga oxidation ponds system. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 83.



N = 26
Kendall tau = +0.425
p level = 0.002 [>FDR, p = 0.012]
Significant at p < 0.05
after FDR application

Figure 83 LOWESS trend plot of MCI data at the site upstream of the Kaponga oxidation ponds system

A strong positive temporal trend in MCI scores has been found over the fifteen-year period which has been statistically significant at the 5% level and after FDR application. This has been more pronounced since 2001 but scores plateaued for about three years before a more recent very gradual improvement. The wide range of LOWESS-smoothed range of scores (20 units) has ecological significance over the fifteen year period, particularly over the first nine years of the monitoring period, and may have been related partly to improved dairyshed wastes disposal consents' compliance reported in this catchment. Smoothed MCI scores consistently indicated 'good' generic river health (Table 1) with a tendency toward 'very good' most recently. In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain river, health has been 'better than expected' throughout the fifteen year period.

3.2.19.3 Site upstream of Kapuni railbridge (KPK000660)

3.2.19.3.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken in the Kaupokonui River at this mid-reach site upstream of the Kapuni railbridge between 1995 and February 2009. These results are summarised in Table 88, together with the results from the current period, and illustrated in Figure 84.

Table 88 Results of previous surveys performed in the Kaupokonui River upstream of Kapuni railbridge, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1996 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000660	28	15-32	24	71-118	99	20	122	23	104

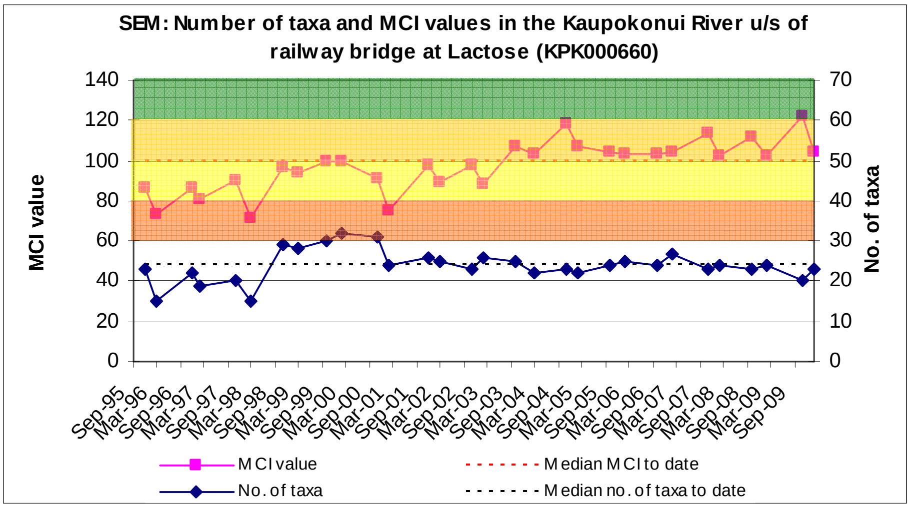


Figure 84 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kapuni railbridge

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 2009-2010 period spring (20 taxa) and summer (23 taxa) richnesses were relatively similar and slightly lower than the median taxa number in both spring and summer, when similar substrate periphyton covers were recorded.

MCI values have had a wide range (47 units) at this site, wider than typical of sites in the mid reaches of ringplain rivers. However, the median value (99 units) has been typical of mid reach sites elsewhere on the ringplain. The spring, 2009 (122 units) and summer, 2010 (104 units) scores were higher than typical of this site and significantly higher than the historical median in spring when the score was 4 units higher than the historical maximum. These scores categorised this site as having 'very good' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'well above expected' health in spring and 'better than expected' in summer for the mid reaches of a ringplain river. The historical median score (99 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.19.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 89.

Table 89 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kaupokonui River upstream of Kapuni railbridge between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	8	29		
ANNELIDA	Oligochaeta	1	18	64		
	Lumbricidae	5	1	4		
MOLLUSCA	*Potamopyrgus*	4	3	11		A
CRUSTACEA	Ostracoda	1	1	4		
EPHEMEROPTERA	*Austroclima*	7	1	4		
	Coloburiscus	7	11	39	A	
	Deleatidium	8	17	61	XA	VA
PLECOPTERA	*Acroperla*	5	0	0	A	
HEMIPTERA	*Sigara*	3	1	4		
COLEOPTERA	Elmidae	6	21	75	VA	VA
	Hydraenidae	8	1	4		
MEGALOPTERA	*Archichauliodes*	7	11	39		A
TRICHOPTERA	*Aoteapsyche*	4	14	50		VA
	Costachorema	7	4	14		
	Hydrobiosis	5	13	46		A
	Beraeoptera	8	1	4		
	Oxyethira	2	6	21		
	Pycnocentrodes	5	6	21		
DIPTERA	*Aphrophila*	5	15	54	A	
	Eriopterini	5	0	0	A	
	Chironomus	1	1	4		
	Maoridiamesa	3	18	64	A	
	Orthocladiinae	2	25	89	A	A
	Tanytarsini	3	4	14		
	Empididae	3	2	7		
	Muscidae	3	2	7		
	Austrosimulium	3	5	18		

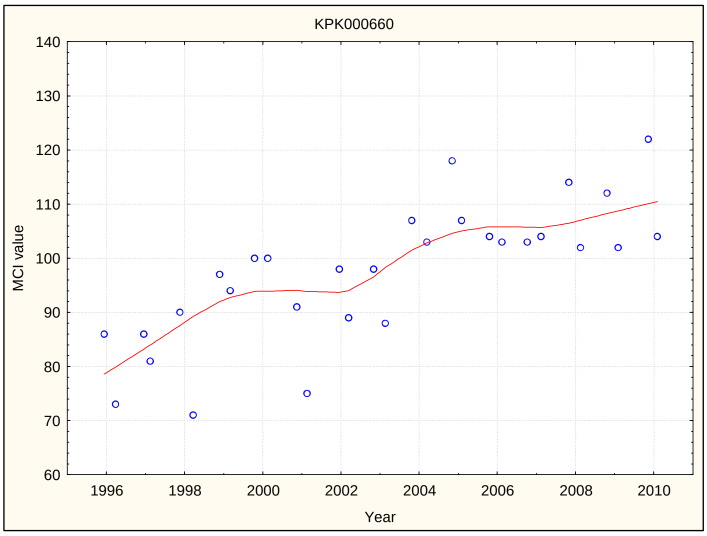
Prior to the current 2009-2010 period, 26 taxa had characterised the community at this site on occasions. These have comprised three 'highly sensitive', nine 'moderately sensitive', and fourteen 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a high proportion of 'tolerant' taxa as might be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); five 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)); and four 'tolerant' taxa (oligochaete worms, free-living caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)). Six of thes historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive' taxon, three 'moderately sensitive' taxa, and two 'tolerant' taxa, together with an additional two 'moderately sensitive' taxa not previously recorded in abundance on any occasion. One 'highly sensitive', three 'moderately sensitive', and three 'tolerant' taxa comprised the dominant taxa of the summer community. Only three of these twelve taxa were dominant in both spring and summer communities (Table 89) . An increased numerical dominance by 'tolerant' taxa and increased abundances within certain of these taxa (e.g. snail and caddisfly) and a decrease in number within the 'highly sensitive' mayfly taxon in summer were reflected in the moderate decrease (1.5 units) in summer seasonal $SQMCI_s$ score (Tables 162 and 163). The three taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 50% to 75% of past survey occasions.

3.2.19.3.3Predicted 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 102 (altitude) and 101 (distance) for this site. The historical site median (99) is only 3 units lower than the altitude prediction and two units lower than the distance predictive value. The spring, 2009 survey score (122 units) was significantly higher than both predictive values but the summer, 2010 score (104 units) was higher than both predictive values by only 1 to 3 units. Of the 30 surveys to date at this site, 53% of MCI scores have been less than 101 units while only 40% have been greater than 102 units.

3.2.19.3.4Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Kaupokonui River upstream of the Kapuni railbridge. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 85.



N = 30
Kendall tau = +0.587
p level < 0.001 [>FDR, p = 0.0001]
Significant at p < 0.05 and p < 0.01
(after FDR)

Figure 85 LOWESS trend plot of MCI data at the site upstream of Kapuni railbridge

A very strong, statistically significant temporal improvement in MCI scores has bee found at this mid-catchment site. This trend has been similar to, but stronger than, that found at the nearest river site upstream and the very wide range of LOWESS-smoothed scores (32 units) has been ecologically very significant. 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 1) indicated by smoothed MCI scores, has moved from 'poor' to 'fair' during the first half of the period, improving to 'good' where it has remained since 2003. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain river, health has improved from 'worse than expected' (prior to 1998), through 'expected', to 'better than expected' where it has remained since 2003.

3.2.19.4 Upper Glenn Road site (KPK000880)

3.2.19.4.1Taxa richness and MCI

Twenty- eight surveys have been undertaken in the Kaupokonui River at this lower reach site at Upper Glenn Road between 1995 and February 2009. These results are summarised in Table 90, together with the results from the current period, and illustrated in Figure 86.

Table 90 Results of previous surveys performed in the Kaupokonui River at Upper Glenn Road, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1996 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000880	28	14-31	19	66-101	91	17	89	18	89

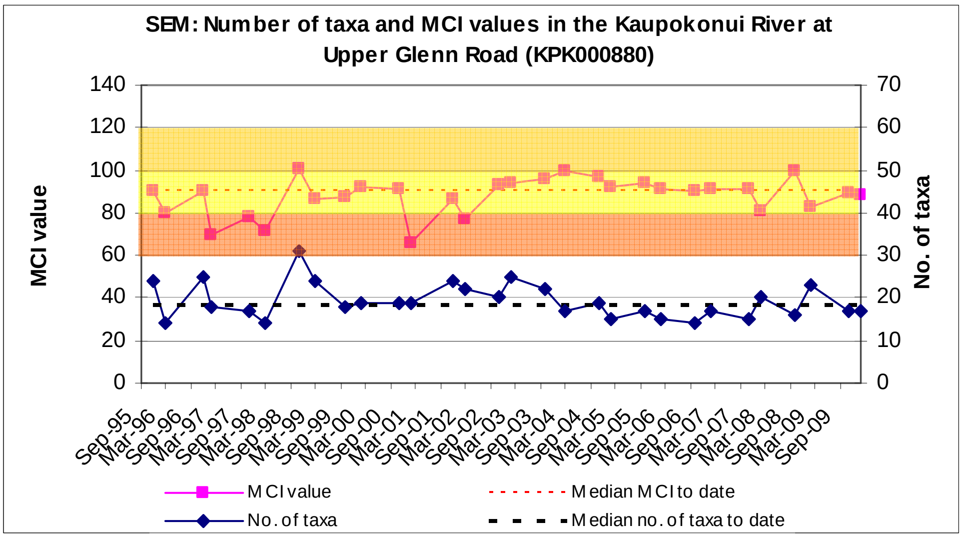


Figure 86 Numbers of taxa and MCI values in Kaupokonui River at Upper Glenn Road

A wide range of richnesses (14 to 31 taxa) has been found with a median richness of 19 taxa (representative of typical richnesses in the lower reaches of ringplain streams and rivers). During the 2009-2010 period spring (17 taxa) and summer (18 taxa) richnesses were very similar and within two taxa of median taxa number.

MCI values have had a wide range (35 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, 1999 (updated, 2009)), however. The spring, 2009 (89 units) and summer, 2010 (89 units) scores were identical and typical of scores at this site, and were within 2 units of the historical median. These scores categorised this site has having 'fair' health generically (Table 1) on both occasions and, in terms of predictive relationships (Table 2), 'expected' health on both occasions for the lower reaches of a ringplain river. The historical median score (91 units) placed this site in the 'fair' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.19.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 91.

Table 91 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kaupokonui River at Upper Glenn Road between 1995 and February 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
PLATYHELMINTHES	*Cura*	3	1	4		
NEMERTEA	Nemertea	3	5	18		
ANNELIDA	Oligochaeta	1	25	89	VA	XA
MOLLUSCA	*Latia*	5	1	4		
	Physa	3	2	7		
	Potamopyrgus	4	9	32		VA
CRUSTACEA	Ostracoda	1	1	4		
	Paracalliope	5	1	4		
EPHEMEROPTERA	*Coloburiscus*	7	2	7		
	Deleatidium	8	12	43	VA	
	Nesameletus	9	1	4		
COLEOPTERA	Elmidae	6	21	75	VA	VA
MEGALOPTERA	*Archichauliodes*	7	2	7		
TRICHOPTERA	*Aoteapsyche*	4	16	57	VA	VA
	Costachorema	7	2	7		
	Hydrobiosis	5	16	57	A	A
	Oxyethira	2	6	21		
	Pycnocentrodes	5	10	36		A
DIPTERA	*Aphrophila*	5	5	18		
	Chironomus	1	1	4		
	Maoridiamesa	3	17	61	VA	
	Orthocladiinae	2	26	93	VA	XA
	Tanytarsini	3	5	18		
	Ephydridae	4	1	4		
	Muscidae	3	2	7		
	Austrosimulium	3	2	7		

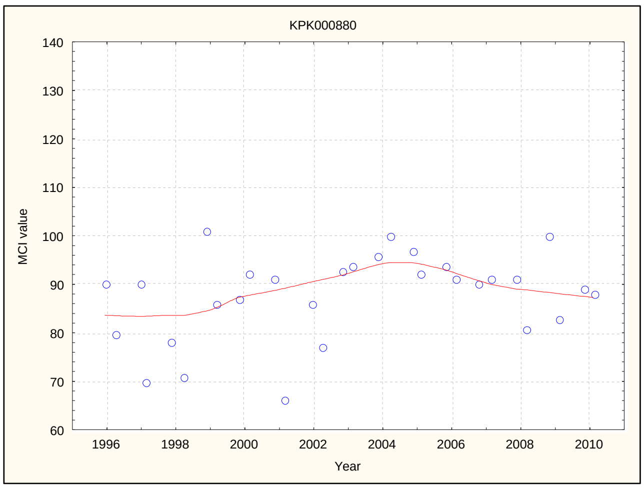
Prior to the current 2009-2010 period, 26 taxa had characterised the community at this site on occasions. These have comprised two 'highly sensitive', nine 'moderately sensitive', and fifteen 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); three 'moderately sensitive' taxa (elmid beetles and caddisflies (*Hydrobiosis* and *Pycnocentrodes*)); and five 'tolerant' taxa (oligochaete worms, snails (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)). Seven of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive', two 'moderately sensitive', and four 'tolerant' taxa, whereas no 'highly sensitive', three 'moderately sensitive', and four 'tolerant' taxa comprised the dominant taxa of the summer, 2010 community. Five of these nine taxa were dominant in both spring and summer communities (Table 91). The increased numerical summer dominance by three 'tolerant' taxa in particular and absence of the 'highly sensitive' mayfly were reflected in the significant drop of 1.7 units in seasonal $SQMCI_s$ scores (Tables 162 and 163). The seven taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 32% to 93% of past survey occasions.

3.2.19.4.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 91 (altitude) and 95 (distance) for this site. The historical site median (95) is equivalent to the altitude prediction and 4 units lower than the predictive distance value. The spring, 2009 and summer, 2010 survey scores (89 units) were within 6 units of both predictive values. Of the 30 surveys to date at this site, 53% of MCI scores have been less than 91 units while only 17% have been greater than 95 units.

3.2.19.4.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Kaupokonui River at Upper Glenn Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 87.



N = 30
Kendall tau = +0.163
p level = 0.205 [>FDR, p = 0.355]
N/S at $p < 0.05$

Figure 87 LOWESS trend plot of MCI data at the Upper Glenn Road site

A temporal trend of improvement in MCI scores was found at this site up until 2005 followed by a gradual decline, but the overall trend was not statistically significant. The LOWESS-smoothed range of MCI scores (10 units) has not been ecologically significant and nowhere near as wide as that upstream indicative of decreasing effects in a downstream direction. The overall positive temporal 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.

Smoothed MCI scores have consistently indicated 'fair' generic river health (Table 1) throughout the period, although prior to 2003 individual scores varied between 'fair' and 'poor' health. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain river, river health has improved from 'expected' (prior to 2002) to 'better than expected' (for the period until 2007) prior to a more recent return to the 'expected' category.

3.2.19.5 Kaupokonui Beach site (KPK000990)

3.2.19.5.1Taxa richness and MCI

Twenty surveys have been undertaken in the Kapokonui River at this lower reach site at Kaupokonui Beach between 1999 and February 2009. These results are summarised in Table 92, together with the results from the current period, and illustrated in Figure 88.

Table 92 Results of previous surveys performed in the Kaupokonui River at the Kaupokonui Beach site, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1999 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000990	20	11-26	19	69-98	87	19	91	20	94

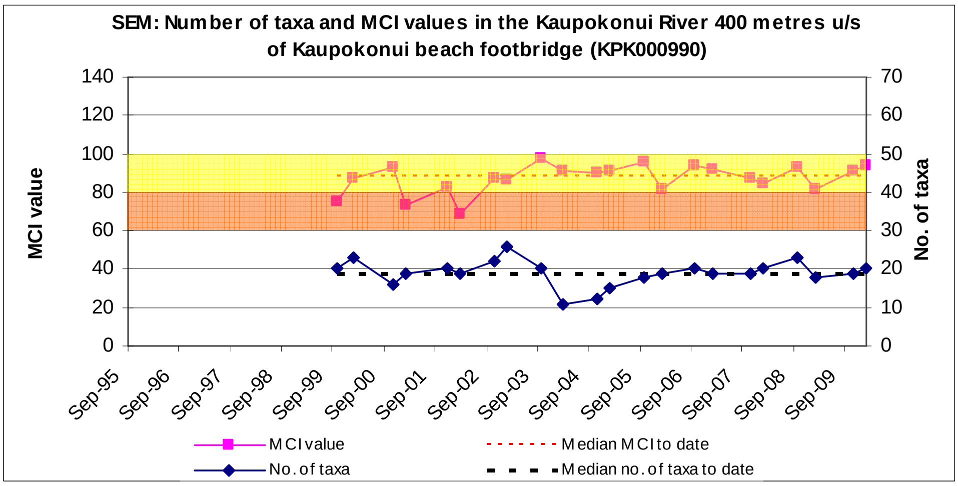


Figure 88 Numbers of taxa and MCI values in the Kaupokonui River at the Kaupokonui Beach site

A wide range of richnesses (11 to 26 taxa) has been found, with a median richness of 19 taxa. During the 2009-2010 period spring (19 taxa) and summer (20 taxa) richnesses were very similar and within one taxon of the median richness.

MCI values have had a moderate range (29 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (87 units) has been relatively typical of scores at lower reach sites elsewhere on the ringplain (TRC, 1999 (updated, 2009)). The spring, 2009 (91 units) and summer, 2010 (94 units) scores were relatively similar and also typical for such a site and within 7 units of the historical median. These scores categorised this site as having 'fair' health generically (Table 1) on both occasions and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the lower reaches of a ringplain river. The historical median score (87 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.19.5.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 93.

Table 93 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kaupokonui River at the Kaupokonui Beach site between 1999 and February 2009 [20 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	3	15		
ANNELIDA	Oligochaeta	1	19	95	A	XA
MOLLUSCA	*Potamopyrgus*	4	9	45	VA	VA
EPHEMEROPTERA	*Austroclima*	7	1	5		
	Deleatidium	8	13	65	VA	
COLEOPTERA	Elmidae	6	16	80	A	
TRICHOPTERA	*Aoteapsyche*	4	12	60	A	VA
	Costachorema	7	2	10	A	
	Hydrobiosis	5	14	70	A	A
	Pycnocentrodes	5	10	50	VA	VA
DIPTERA	*Aphrophila*	5	1	5		
	Maoridiamesa	3	13	65	VA	A
	Orthocladiinae	2	19	95	VA	XA
	Tanytarsini	3	6	30		
	Muscidae	3	1	5		

Prior to the current 2009-2010 period, 15 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', six 'moderately sensitive', and eight 'tolerant' taxa i.e. a low proportion 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 one 'highly sensitive' taxon (mayfly (*Deleatidium*)); three 'moderately sensitive' taxa (elmid beetles, free-living caddisfly (*Hydrobiosis*), and stony-cased caddisfly (*Pycnocentrodes*)); and six 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa,* tanytarsids, and orthoclads)). Ten of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive' taxon, four 'moderately sensitive' taxa, and five 'tolerant' taxa, whereas two 'moderately sensitive' and five 'tolerant' taxa comprised the dominant taxa of the summer, 2010 community. Seven of these ten taxa were dominant in both spring and summer communities (Table 93) but increased numerical abundances in three 'tolerant' taxa and the loss of the 'highly sensitive' mayfly taxon was reflected in the significant summer decrease of (2.1 units) in $SQMCI_s$ score (Tables 162 and 163).

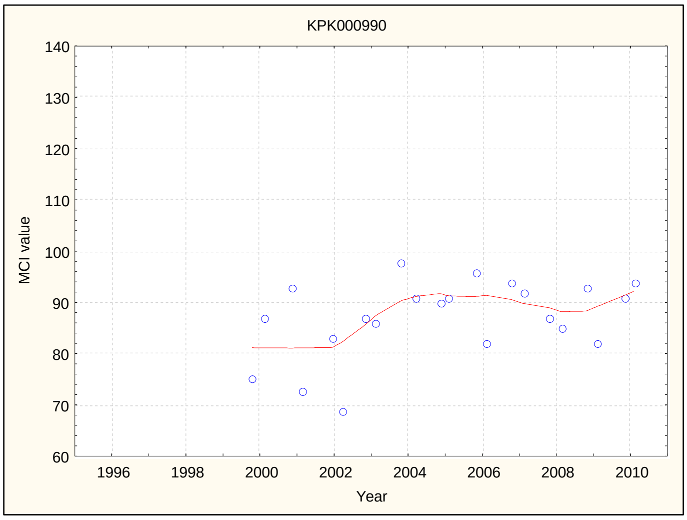
The seven taxa recorded as very or extrememly abundant during spring and/or summer have characterised this site's communities on 45% to 95% of past survey occasions.

3.2.19.5.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 85 (altitude) and 93 (distance) for this site. The historical site median (87) is 2 units higher than the altitude and 6 units below the distance predictive values. The spring 2009 survey score (91 units) was within 6 units of both predictive values while the summer score (94 units) was 9 units higher than the predictive altitude and one unit above the distance values. Of the 22 surveys to date at this site, 27% of MCI scores have been less than 85 units while only 18% have been greater than 93 units.

3.2.19.5.4 Temporal trends in 1999 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the eleven years of SEM results collected to date from the site in the Kaupokonui River at Kaupokonui Beach. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 89.



N = 22
Kendall tau = +0.238
p level = 0.120 [>FDR, p = 0.232]
N/S at $p < 0.05$

Figure 89 LOWESS trend plot of MCI data at the Kaupokonui Beach site

Although the eleven year trend in MCI scores has indicated some improvement, the overall temporal trend has not been statistically significant. However, an ecologically significant range of LOWESS-smoothed scores (11 units) has been recorded, possibly reflecting certain upstream improvements in waste disposal management (documented earlier).

Individual MCI scores have been indicative of generic river health (Table 1) varying between 'poor' and 'fair' prior to 2003 improving to 'fair' where scores have remained consistently since this date. LOWESS-smoothed scores have been indicative of 'fair' generic river health throughout the period. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, river health has improved from 'expected' between 1995 and 2003 to 'better than expected' over the subsequent seven years.

3.2.19.6 Discussion

Seasonal MCI values typically decreased between spring and summer at the two sites below the Opunake Road site (which increased by 7 units) by 6 and 18 units respectively in a downstream direction prior to no change at the Upper Glenn Road site and an increase of 3 units at the Kaupokonui Beach site. Seasonal communities shared 64% of 33 taxa at the Opunake Road upper mid-reach site, 50% of 34 taxa at the Kaponga mid-reach site, 59% of 27 taxa at the Kapuni Railbridge mid-reach site, 55% of 22 taxa at the Upper Glenn Road lower reach site, and 63% of 24 taxa at the furthest downstream site (Kaupokonui Beach) in the lower reaches. Seasonal community compositions were generally more variable in the mid-reaches of this river rather than with increasing distance downstream from the National Park (as in the Waingongoro River).

Community composition varied markedly through the length of the river surveyed. A total of 36 taxa was recorded in spring of which only nine taxa were present at all five sites. These included one 'highly sensitive' taxon, five 'moderately sensitive' taxa, and three 'tolerant' taxa with only the 'highly sensitive' mayfly (*Deleatidium*), 'moderately sensitive' elmid beetle and 'tolerant' midge (*Maoridiamesa*) abundant at all five sites. A higher total of 44 taxa was found along the river's length by the summer survey of which eight taxa were present at all five sites. These were very similar to the nine widespread taxa in spring with the loss of one 'tolerant' taxon. Only the one 'tolerant' net-building caddisfly was abundant at all five sites. These dissimilarities in spatial community structure along the length of the Kaupokonui River were just as pronounced in spring as in summer.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 36 units in spring and 40 units in summer, over a river distance of 27.8 km. These seasonal falls in MCI scores equated to rates of decline of 1.3 units/km (spring) and 1.4 units/km (summer), compared with a predicted rate of 0.9 unit/km for the equivalent length and reach of a National Park-sourced river (Stark and Fowles, 2009). Although small, this was typical of the trend of most past summers' seasonal increases in rates of decline. This may be compared with a rate of 0.7 unit/km derived for the nearby Waingongoro River (over a 15 year period) which, although a ringplain National Park-sourced river, has an atypical meandering nature over more than twice the length of the Kaupokonui River.

Between the upper mid-reach (Opunake Road) site and Kapuni mid-reach site the spring (0.4 unit/km) and summer (2.5 units/km) rates of decline were much different to the predicted rate (1.4 units/km) for the equivalent river reach. For the mid-reach Kapuni site to Kaupokonui Beach lower reach site, spring (2.0 units/km) and summer (0.6 unit/km) rates of decline were very different and the spring rate well above the predicted rate of 0.5 unit/km.

Using the long-term median SEM MCI scores for each site (Appendix II), the rates of decline between upper mid-reach site (Opunake Road) and mid-catchment (Kapuni) site, and between this mid-catchment site and lower river site at Kaupokonui Beach, have been about 2.4 and 0.7 units per km respectively with an overall rate of decline of 1.4 MCI units/km over the river's length. Therefore overall rates of decline over the 2009-2010 period were very similar in both spring and summer to typical of rates prior to 2010.

3.2.20 Katikara Stream

Two sites in the Katikara Stream, one located near the headwaters (just inside the National Park) and the other near the coast, were included in the SEM programme in the 2000-2001 year, for the purpose of long term monitoring of the impacts of riparian vegetation planting initiatives within this north-western Taranaki catchment. In the previous year, severe headwater erosion events impacted upon the macroinvertebrate communities of the upper reaches of this stream (TRC, 2009). The results found in the 2009-2010 surveys are presented in Tables 164 and 165, Appendix I.

3.2.20.1 Carrington Road site (KTK000150)

3.2.20.1.1 Taxa richness and MCI

Twenty surveys have been undertaken at this upper reach site in the Katikara Stream inside the National park boundary at Carrington Road between 1999 and March 2009. These results are summarised in Table 94, together with the results from the current period, and illustrated in Figure 90.

Table 94 Results of previous surveys performed in the Katikara Stream at Carrington Road, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KTK000150	20	11-38	32	112-148	138	17	129	15	139

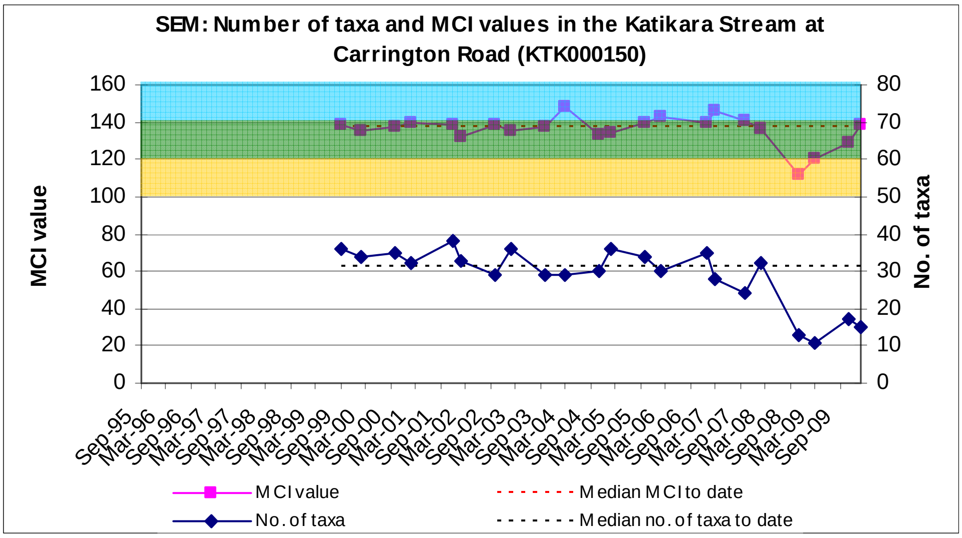


Figure 90 Numbers of taxa and MCI values in the Katikara Stream at Carrington Road

A wide range of richnesses (11 to 38 taxa) has been found; wider than might be expected, due to headwater erosion effects over the 2008-2009 period, with a median richness of 32 taxa (far more representative of typical richnesses in ringplain streams and rivers near the National Park boundary). During the 2009-2010 period spring (17 taxa) and summer (15 taxa) richnesses were lower than this median richness indicative of a continuing post-headwater erosion recovery phase.

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 after the 2008-2009 headwater erosion period. The median value (138 units) has been typical of upper reach sites (near or within the National Park) elsewhere on the ringplain however, and the spring, 2009 (129 units) and summer, 2010 (139 units) scores were relatively typical for such a site, 9 units lower and near the historical median respectively. These scores categorised this site as having 'very good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'worse than expected to 'better than expected' health for the upper reaches of a ringplain stream on spring and summer occasions respectively. The historical median score (138 units) placed this site in the 'very good' category for the generic, and 'better than expected' category for the predictive methods of assessment.

3.2.20.1.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 95.

Table 95 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Katikara Stream at Carrington Road between 1999 and February 2009 [20 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
EPHEMEROPTERA	*Ameletopsis*	10	1	5		
	Austroclima	7	15	75		
	Coloburiscus	7	18	90		
	Deleatidium	8	18	90	A	
	Nesameletus	9	13	65	A	
PLECOPTERA	*Acroperla*	5	2	10		
	Austroperla	9	6	30		
	Zelandobius	5	18	90		
	Zelandoperla	8	7	35	VA	A
COLEOPTERA	Elmidae	6	7	35		
TRICHOPTERA	*Costachorema*	7	1	5		
	Hydrobiosis	5	0	0		A
	Hydrobiosella	9	7	35		
	Orthopsyche	9	8	40		
	Beraeoptera	8	1	5		
DIPTERA	*Aphrophila*	5	5	25		
	Orthocladiinae	2	13	65		A

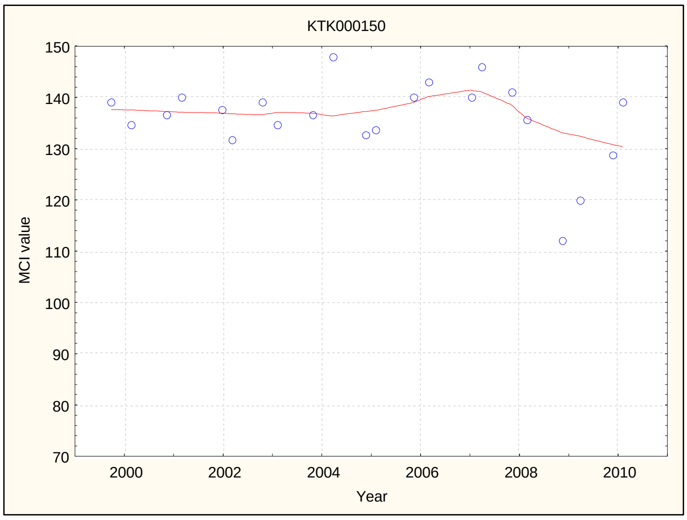
Prior to the current 2009-2010 period, 16 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', seven 'moderately sensitive', and one 'tolerant' taxa i.e a majority of 'sensitive' taxa as would be expected near the National Park boundary of a ringplain stream. Predominant taxa have included six 'highly sensitive' taxa (mayflies (*Deleatidium* and *Nesameletus*) stoneflies (*Zelandoperla* and *Austroperla*), and free-living caddisflies (*Orthopsyche* and *Hydrobiosella*)); four 'moderately sensitive' taxa (mayflies (*Coloburiscus* and *Austroclima*), stonefly (*Zelandobius*), and elmid beetles) and one 'tolerant' taxon (orthoclad midges). Three of these taxa (all 'highly sensitive' taxa) were dominant in the spring, 2009 community. Only one of these three taxa was again dominant in the summer, 2010 community together with one 'tolerant' historically characteristic taxon of this site (orthoclad midges) and another 'moderately sensitive' taxon (caddisfly (*Hydrobiosis*)), which, although found at this site previously, had not been a characteristic taxon. Only one 'tolerant' taxon was dominant and only on the summer sampling occasion coincident with minimal periphyton substrate cover at this site. These differences in seasonal characteristic community compositions were reflected in the significant summer decrease of 1.9 units in $SQMCI_s$ values (Tables 164 and 165). The one taxon recorded as very abundant at the time of the spring survey had characterised this site's communities on 35% of past survey occasions.

3.2.20.1.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 127 (altitude) and 132 (distance) for this site. The historical site median (138 units) is a significant 11 units higher than the altitude prediction and 6 units higher than the distance predictive value. The spring score (129 units) was within 3 units of both predictive values and the summer score (139 units) was significantly higher (Stark, 1998) than the altitude predictive value. Of the 22 surveys to date at this site, only 9% of MCI scores have been less than 127 units while 86% have been greater than 132 units.

3.2.20.1.4 Temporal trends in 1999 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the eleven years of SEM results collected to date from the site in the Katikara Stream at Carrington Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 91.



N = 22
Kendall tau = -0.057
p level = 0.709 [>FDR, p = 0.785]
N/S at $p < 0.05$

Figure 91 LOWESS trend plot of MCI data 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 most recent downward trend has been due to significant headwater erosion effects during 2008. However, the overall temporal trend has not been statistically significant and the range of LOWESS-smoothed scores (10 units) over the period has not quite been ecologically significant, the range having widened markedly since the erosion event. Smoothed scores have been indicative of 'very good' generic steram health (Table 1) throughout the period and, in terms of predictive relationships (Table 2) for a site in the upper reaches of a ringplain stream at the boundary of the National Park, stream health has been 'better than expected' throughout the first nine years falling into the 'expected' category since the headwater erosion impacts during 2008.

3.2.20.2 Coastal site (KTK000248)

3.2.20.2.1Taxa richness and MCI

Nineteen surveys have been undertaken in the Katikara Stream at this lower reach site near the coast between 2000 and March 2009. These results are summarised in Table 96, together with the results from the current period, and illustrated in Figure 92.

Table 96 Results of previous surveys performed in the Katikara Stream near the coast, prior to spring 2009, together with spring 2009 and summer 2010

Site code	SEM data (1995 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KTK000248	19	20-31	25	81-116	103	25	97	26	107

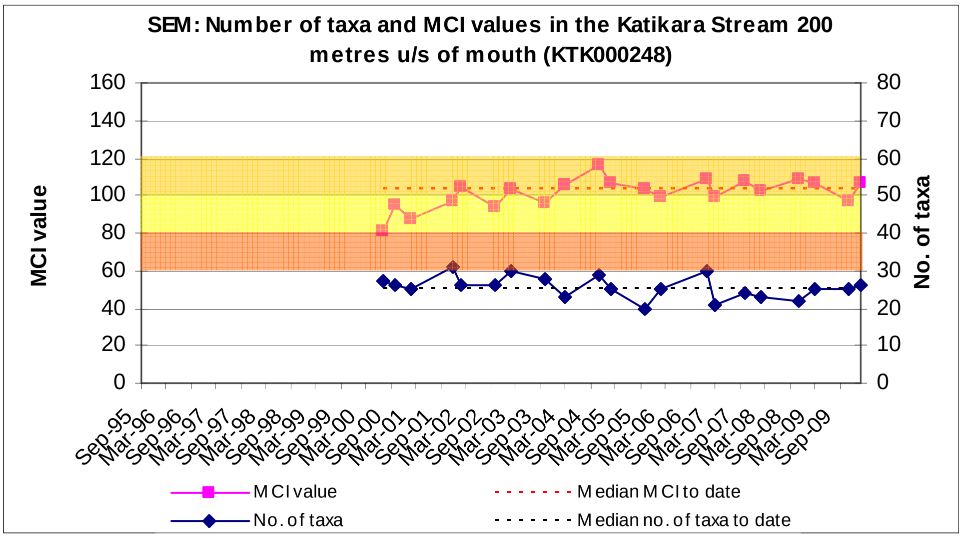


Figure 92 Numbers of taxa and MCI values in the Katikara Stream 200m u/s of the coast

A moderate range of richnesses (20 to 31 taxa) has been found, with a median richness of 25 taxa (more representative of typical richnesses in the lower reaches of ringplain streams and rivers). During the 2009-2010 period, spring (15 taxa) and summer (26 taxa) richnesses were almost identical and within one taxon of the median taxa number in both seasons.

MCI values have had a relatively wide range (35 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (103 units) has been higher than typical of lower reach sites elsewhere on the ringplain however, with the spring, 2009 (97 units) and summer, 2010 (107 units) scores well above those typical for such a site and within 7 units of the historical median. These scores categorised this site as having 'fair' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationshps (Table 2), 'better than expected' (spring) and 'well above expected' (summer) health for the lower reaches of a ringplain stream. The historical median score (103 units) placed this site in the 'good' category for the generic and 'better than expected' category for the predictive methods of assessment.

3.2.20.2.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 97.

Table 97 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Katikara Stream near the mouth between 2000 and February 2009 [19 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	4	21		
ANNELIDA	Oligochaeta	1	13	68	A	A
MOLLUSCA	*Latia*	5	2	11		
	Potamopyrgus	4	18	95	XA	A
CRUSTACEA	*Paratya*	3	2	11		
EPHEMEROPTERA	*Austroclima*	7	10	53	A	A
	Coloburiscus	7	8	42		
	Deleatidium	8	10	53	A	VA
PLECOPTERA	*Zelandoperla*	8	1	5		
COLEOPTERA	Elmidae	6	15	79	VA	XA
	Ptilodactylidae	8	2	11		
MEGALOPTERA	*Archichauliodes*	7	6	32	A	A
TRICHOPTERA	*Aoteapsyche*	4	16	84	VA	XA
	Costachorema	7	6	32		
	Hydrobiosis	5	12	63		A
	Pycnocentrodes	5	16	84	VA	VA
DIPTERA	*Aphrophila*	5	11	58	A	A
	Maoridiamesa	3	5	26	A	A
	Orthocladiinae	2	15	79	A	A
	Tanytarsini	3	2	11		A
	Austrosimulium	3	7	37		

Prior to the current 2009-2010 period, 21 taxa had characterised the community at this site on occasions. These have comprised three 'highly sensitive', nine '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*)); eight 'moderately sensitive' taxa (mayflies (*Coloburiscus* and *Austroclima*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisflies

(*Costachorema* and *Hydrobiosis*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)); and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*)), orthoclad midges, and sandfly (*Austrosimulium*)). Eleven of the historically characteristic taxa were dominant in the spring, 2009 community. These comprised one 'highly sensitive' taxon, five 'moderately sensitive', and five 'tolerant' taxa, whereas the same taxa plus one 'moderately sensitive' and one 'tolerant' taxa comprised the dominant taxa of the summer community. Eleven of these 13 taxa were dominant in both spring and summer communities (Table 97) and this was reflected in the relatively similar seasonal $SQMCI_s$ scores (Table 164 and 165) which increased by 0.7 unit mainly due to increased abundances of elmid beetles but particularly to decreased snail numbers in summer. All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 53% to 95% of past survey occasions.

3.2.20.2.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 85 (altitude) and 99 (distance) for this site. The historical site median (103) is a significant 18 units higher than the altitude prediction and 4 units higher than the distance predictive value. The spring survey score (97 units) was significantly higher than the predictive altitude value while the summer score (107 units) was also significantly higher (Stark, 1998) than the predictive altitude value. Of the 21 surveys to date at this site, only 5% of MCI scores have been less than 85 units while 57% have been greater than 99 units, confirmation of the 'better than expected' stream health at this site.

3.2.20.2.4 Temporal trends in 2000 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the ten years of SEM results collected to date from the site in the Katikara Stream near the coast. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 93.

N = 21
Kendall tau = +0.412
p level = 0.009 [>FDR, p = 0.034]
Significant at p <0.05 and after FDR application

Figure 93 LOWESS trend plot of MCI data at the coastal site

A relatively strong temporal improvement in MCI scores has been recorded, particularly during the first five years of the ten year monitoring period. This trend has levelled off over the most recent five year period but overall has statistical significance after FDR application. The wide range of LOWESS-smoothed MCI scores (20 units) has particular ecological significance and has occurred coincidentally with retirement and riparian planting of the margins of the lower reaches of this stream.

Smoothed MCI scores indicative of 'fair' generic stream health (Table 1) have improved to 'good' health after 2003 where they have remained (Figure 93). In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, stream health has improved from 'expected' to 'better than expected' (approaching 'well above expected' on occasions) where it has remained since 2003.

3.2.20.3 Discussion

Seasonal MCI values atypically improved between spring and summer (by 10 units) at both sites with the percentage composition of 'tolerant' taxa decreasing slightly in the summer communities. Seasonal communities at the upper site shared only 11 common taxa (52% of the 21 taxa found at this site in 2009-2010) compared with 21 shared common taxa (70% of the 30 taxa found in the 2009-2010) at the lower reaches site near the coast; an atypically more pronounced seasonal change in community structure at the upstream site. The two sites shared only 10 common taxa (32% of the 31 taxa at upper and lower reach sites) in spring and 9 common taxa (28% of 32 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and summer.

MCI score typically fell in a downstream direction in spring (by 32 units) but equally in summer (by 32 units), over a stream distance of 18.1 km downstream from the National Park boundary. These falls equated to rates of decline of 1.8 units/km in spring and in summer, identical to the predicted rate of 1.8 units/km over the equivalent length and reach of a National Park-sourced stream (Stark and Fowles, 2009).

Using the long-term median SEM MCI scores for both sites (Appendix II), the rate of decline between the upper reach site and lower reach site near the coast has been 1.9 MCI units/km over the surveyed length. Therefore rates of MCI decline over the 2009-2010 period were only slightly lower in both spring and summer than typical rates for the 1995 to 2009 period.

3.2.21 Kapoaiaia Stream

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. This stream was selected for the purpose of monitoring a western Taranaki catchment with minimal existing riparian vegetation cover. 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 periodic operation of the Pungarehu Dairy Factory. This factory has been closed to dairy operations since 1995.

The results of the spring, 2009 and summer, 2009-2010 surveys are presented in Tables 166 and 167 Appendix I.

3.2.21.1 Wiremu Road site (KPA000250)

3.2.21.1.1 Taxa richness and MCI

Twenty surveys have been undertaken in the Kapoaiaia Stream between 1995 and March 2009 at this open, upper mid-reach site in farmland, 5.7 km downstream of the National Park. These results are summarised in Table 98 together with the results from the current period, and illustrated in Figure 94.

Table 98 Results of previous surveys performed in the Kapoaiaia Stream at Wiremu Road prior to the spring 2009 survey, together with the spring 2009 and summer 2010 results

Site code	SEM data (1995 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000250	20	20-31	25	83-123	105	23	123	19	129

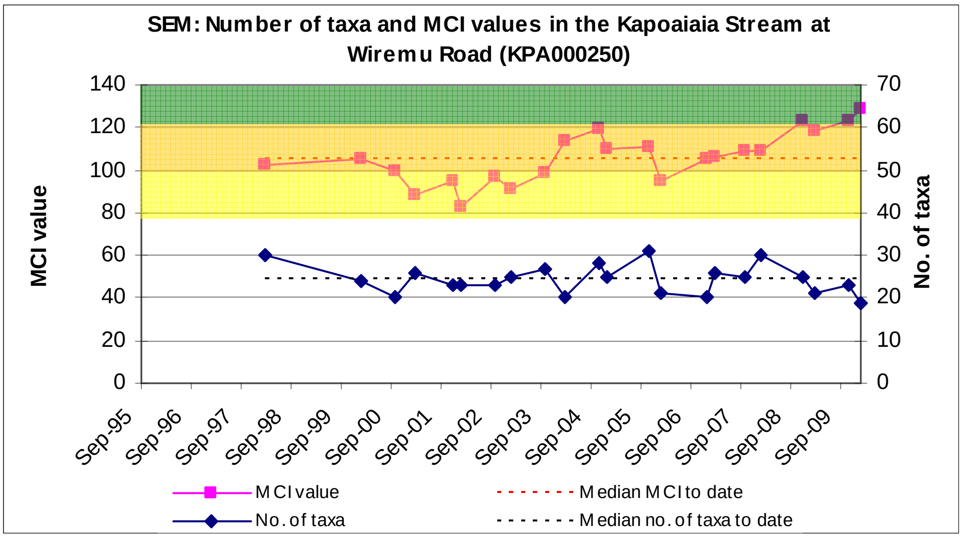


Figure 94 Numbers of taxa MCI values in the Kapoaiaia Stream at Wiremu Road

A moderate range of richnesses (20 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 2009-2010 period, spring (23 taxa) and summer (19 taxa) richnesses were slightly lower than this median richness.

MCI values have had a relatively wide range (40 units) at this site, wider than typical of a site in the upper mid-reaches of a ringplain stream although this site is in more open farmland. The median value (105 units) has been lower than typical of upper mid-reach sites elsewhere on the ringplain. The spring, 2009 (123 units) and summer, 2010 (129 units) scores were significantly 18 and 24 units above the historical median respectively and were equivalent with (spring) and higher than (summer) historical maximum recorded at this site. These scores categorised this site as having 'very good' generic health (Table 1) in spring and summer and, in terms of predictive relationships (Table 2), 'well above expected' health for the mid-reaches of a ringplain stream on both of these occasions. The historical median score (105 units) placed this site in the 'good' and 'better than expected' categories for the generic and predictive methods of assessment respectively.

3.2.21.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 99.

Table 99 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kapoaiaia Stream at Wiremu Road between 1995 and February 2009 [20 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	12	60		
MOLLUSCA	*Potamopyrgus*	4	3	15		
CRUSTACEA	*Paracalliope*	5	1	5		
EPHEMEROPTERA	*Austroclima*	7	4	20		
	Coloburiscus	7	10	50	VA	VA
	Deleatidium	8	12	60	XA	XA
	Nesameletus	9	1	5	A	A
PLECOPTERA	*Acroperla*	5	5	25		
	Zelandoperla	8	4	20	A	
COLEOPTERA	Elmidae	6	18	90	VA	VA
	Hydraenidae	8	1	5		
MEGALOPTERA	*Archichauliodes*	7	2	10		
TRICHOPTERA	*Aoteapsyche*	4	18	90	A	VA
	Costachorema	7	15	75		
	Hydrobiosis	5	9	45		
	Oxyethira	2	4	20		
	Pycnocentrodes	5	2	10		
DIPTERA	*Aphrophila*	5	16	80	A	A
	Eriopterini	5	1	5		
	Maoridiamesa	3	17	85	A	
	Orthocladiinae	2	20	100	A	
	Tanytarsini	3	2	10		
	Muscidae	3	3	15		
	Austrosimulium	3	5	25		

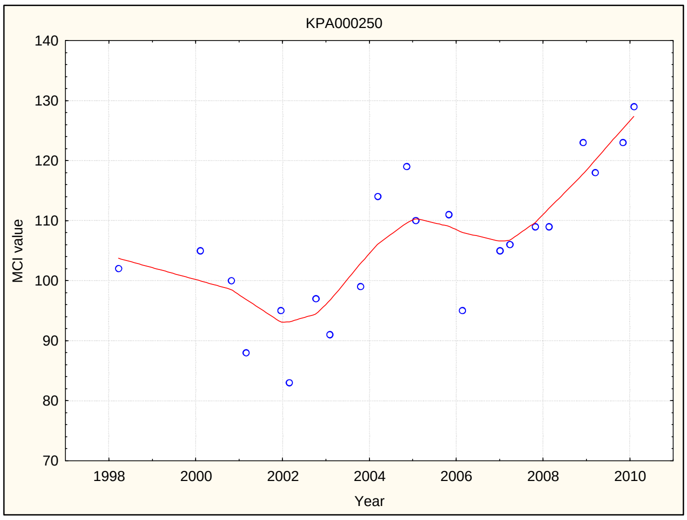
Prior to the current 2009-2010 period, 24 taxa have characterised the community at this site on occasions. These have comprised four ‘highly sensitive’, eleven ‘moderately sensitive’, and nine ‘tolerant’ taxa i.e. a predominance of ‘sensitive’ taxa as would be expected in the upper mid-reaches of a ringplain stream. Predominant taxa have included one ‘highly sensitive’ taxon (mayfly (*Deleatidium*)); five ‘moderately sensitive’ taxa (mayfly (*Coloburiscus*), elmid beetles, free-living caddisflies (*Costachorema* and *Hydrobiosis*), and cranefly (*Aphrophila*)); and four ‘tolerant’ taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)). Seven of these predominant taxa were dominant in the spring, 2009 community together with two other ‘highly sensitive’ taxa while the summer, 2010 community was characterised by all but three of the taxa dominant in spring, all of which had been characteristic of this site’s communities previously (Table 98). The similarity in the seasonally most dominant taxa composition was evident in the minimal 0.1 unit $SQMCI_s$ difference in spring and summer scores (Tables 166 and 167). All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site’s communities on 50% to 90% of the past surveys.

3.2.21.1.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 109 (altitude) and 112 (distance) for this site. The historical site median (105 units) is 4 units lower than the altitude prediction and 7 units lower than the distance predictive value. However, the spring, 2009 survey score (123 units) was significantly (Stark, 1998) higher than both predictive values while the summer, 2010 score (129 units) was also significantly higher (by 17 to 20 units) than both predictive values. Of the 22 surveys to date at this site, 55% of MCI scores have been less than 109 units while only 27% have been greater than 112 units.

3.2.21.1.4 Temporal trends 1995 to 2010

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the SEM results collected to date from the site in the Kapoaiaia Stream at Wiremu Road. The MCI has been chosen as the preferable indicator of ‘stream/river health’ for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 95.



N = 22
Kendall tau = +0.511
p level = 0.001 [>FDR, p = 0.006]
Significant at p <0.05 and after FDR application

Figure 95 LOWESS trend plot of MCI data at the Wiremu Road site

A statistically significant temporal trend of improvement in MCI scores was found over the twelve year duration of this monitoring period and this trend was also significant at p<0.01 after FDR application. There has been an ecologically significant variability in the wide (34 units) range of LOWESS-smoothed scores at this site also. This appears to have been related to farming practices, particularly variations in fertiliser usage, over the reach between the National Park and this upper site, which may have been exacerbated by the lack of riparian vegetation along this reach.

Smoothed MCI scores, indicative of generic stream health (Table 1) varying between 'fair' and 'very good' have been slightly lower than might be expected at times (particularly prior to 2004) at this site approximately 5 km below the National Park. A very strong improvement has been obvious since 2007 which has been maintained over the 2009-2010 period.

In terms of predictive relationships (Table 2) for a site in the upper mid-reaches of a ringplain stream, stream health had been in the 'expected' category prior to 2004 improving to 'better than expected' until 2009 and most recently to the 'well above expected' category.

3.2.21.2 Wataroa Road site (KPA000700)

3.2.21.2.1Taxa richness and MCI

Twenty surveys have been undertaken in the Kapoaiaia Stream at this mid-reach site at Wataroa Road between 1995 and March 2009. These results are summarised in Table 100, together with the results from the current period, and illustrated in Figure 96.

Table 100 Results of previous surveys performed in the Kapoaiaia Stream at Wataroa Road, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000700	20	12-26	20	78-108	91	30	101	17	95

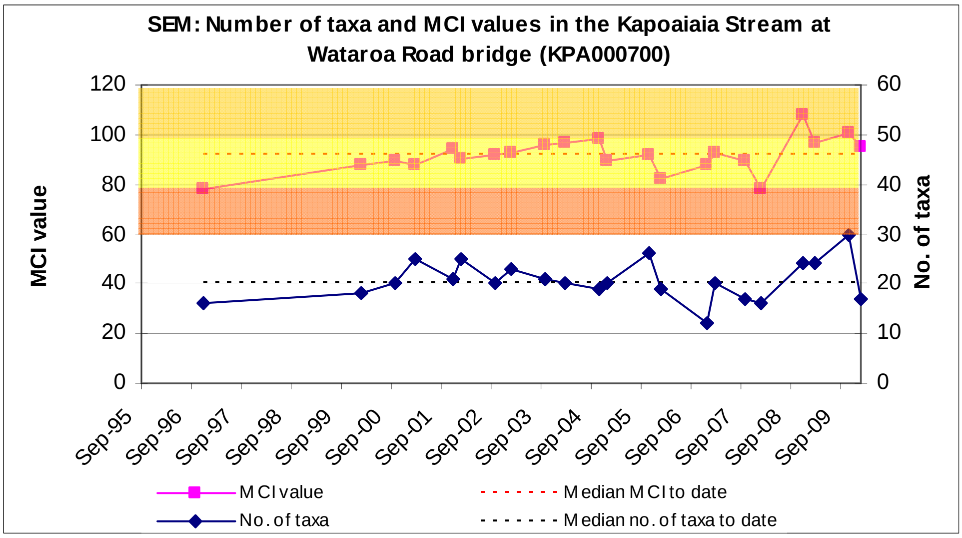


Figure 96 Numbers of taxa and MCI values in the Kapoaiaia Stream at Wataroa Road

A moderately wide range of richnesses (12 to 26 taxa) has been found, with a median richness of 20 taxa, typical of richnesses in the mid-reaches of ringplain streams and rivers. During the 2009-2010 period, spring (30 taxa) and summer (17 taxa) richnesses were very different, very much higher than median taxa number in spring, and almost equivalent with the median taxa number in summer, the latter coincident with more extensive substrate periphyton cover and warmer water temperatures. MCI values have had a relatively wide range (30 units) at this site, more so than typical of many sites in the mid-reaches of ringplain rivers. The median value (91 units) is lower than values typical of mid-reach sites elsewhere on the ringplain however, with the spring, 2009 (101 units) and summer, 2010 (95 units) scores higher than the historical median by 10 and 4 units respectively. These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' (spring) and 'expected' (summer) health for the mid-reaches of a ringplain river. The historical median score (91 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.21.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 101.

Table 101 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kapoaiaia Stream at Wataroa Road between 1995 and March 2009 [20 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
PLATYHELMINTHES	*Cura*	3	1	5		
NEMATODA	Nematoda	3	1	5		
ANNELIDA	Oligochaeta	1	15	75		
	Lumbricidae	5	1	5		
MOLLUSCA	*Potamopyrgus*	4	6	30		
EPHEMEROPTERA	*Austroclima*	7	1	5		
	Deleatidium	8	6	30	A	VA
PLECOPTERA	*Acroperla*	5	0	0	A	
COLEOPTERA	Elmidae	6	17	85	VA	XA
MEGALOPTERA	*Archichauliodes*	7	3	15	A	
TRICHOPTERA	*Aoteapsyche*	4	13	65	A	VA
	Costachorema	7	11	55		
	Hydrobiosis	5	13	65		A
	Oxyethira	2	2	10		
	Pycnocentrodes	5	4	20		
DIPTERA	*Aphrophila*	5	11	55	A	A
	Maoridiamesa	3	11	55	VA	A
	Orthocladiinae	2	18	90	VA	VA
	Tanytarsini	3	3	15		
	Empididae	3	3	15		
	Muscidae	3	1	5		
	Austrosimulium	3	10	50		

Prior to the current 2009-2010 period, 21 taxa had characterised the community at this site on occasions. These have comprised only one ‘highly sensitive’, eight ‘moderately sensitive’, and twelve ‘tolerant’ taxa i.e. a minority of ‘highly sensitive’ taxa and an increase in ‘tolerant’ taxa as would be expected in the mid reaches of a ringplain stream. Predominant taxa have included one ‘highly sensitive’ taxon (mayfly (*Deleatidium*)), four ‘moderately sensitive’ taxa (elmid beetles, free-living caddisflies (*Costachorema* and *Hydrobiosis*), and cranefly (*Aphrophila*)); and five ‘tolerant’ taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), midges (*Maoridiamesa* and orthoclads), and sandfly (*Austrosimulium*)). Seven of these historically characteristic taxa were dominant in the spring, 2009 community together with one ‘moderately sensitive’ taxon (stonefly (*Acroperla*)) previously not recorded in abundance. These seven taxa comprised one ‘highly sensitive’ taxon, three ‘moderately sensitive’ taxa, and three ‘tolerant’ taxa, whereas one ‘highly sensitive’, three ‘moderately sensitive’, and three ‘tolerant’ taxa also comprised the dominant taxa of the summer community. Six of these nine taxa were dominant in both spring and summer communities (Table 101). Increased summer seasonal abundances amongst two ‘sensitive’ taxa in particular were reflected in the increase of 1.1 units in $SQMCI_s$ scores between spring and summer (Tables 166 and 167).

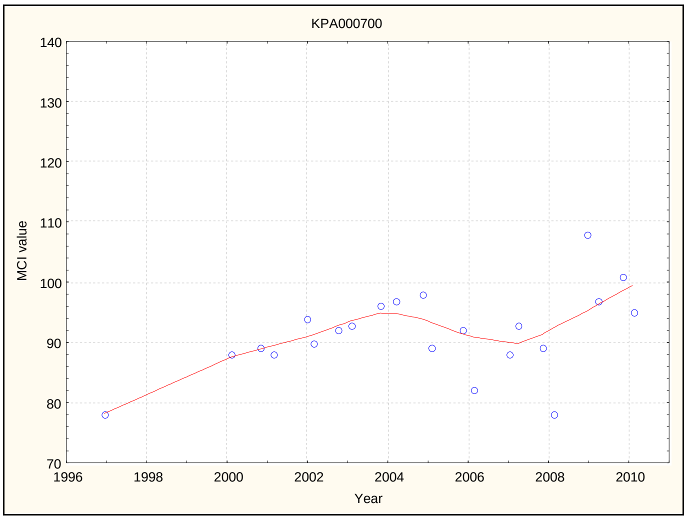
The five taxa found as very and/or extremely abundant by the seasonal surveys have characterised this site’s communities on 30% to 90% of past survey oaccasions.

3.2.21.2.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 99 (altitude) and 103 (distance) for this site. The historical site median (91) is 8 units lower than the altitude prediction and a significant 12 units lower than the distance predictive value. However, the spring, 2009 survey score (101 units) was 2 units higher than the predictive altitude value and 2 units lower than the predictive distance value. The summer, 2010 score (95 units) was lower by up to 8 units than both predictive values. Of the 22 surveys to date at this site, 91% of MCI scores have been less than 99 units while only 5% have been greater than 103 units, confirmation of the poorer than typical historical biological 'health' at this site.

3.2.21.2.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the SEM results collected to date from the site in the Kapoaiaia Stream at Wataroa Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 97.



N = 22
Kendall tau = +0.305
p level = 0.047 [>FDR, p = 0.135]
Significant at p <0.05, N/S after FDR application

Figure 97 LOWESS trend plot of MCI data at the Wataroa Road site

Although the initial six years of the monitoring programme indicated a significant temporal improvement in MCI scores, this tended to reverse between 2004 and 2007. Future recent improvement has resulted in an overall thirteen year trend which has had some statistical significance. The range of LOWESS-smoothed scores (22 units) has been ecologically significant but has been influenced by an initial very low score. From 2000 to date this range has been 12 units.

Smoothed MCI scores have consistently indicated 'fair' generic stream health (Table 1) at this mid-catchment site, bordering on 'good' in the 2009-2010 period. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain stream health has been in the 'expected' category for the period since 2000, approaching the 'better than expected' category in 2009-2010.

3.2.21.3 Upstream of coast site (KPA000950)

3.2.21.3.1 Taxa richness and MCI

Twenty surveys have been undertaken at this lower reach site near the coast in the Kapoaiaia Stream between 1995 and March 2009. These results are summarised in Table 102, together with the results from the current period, and illustrated in Figure 98.

Table 102 Results of previous surveys performed in the Kapoaiaia Stream at the site upstream of the coast prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000950	20	16-24	19	76-98	84	15	83	15	87

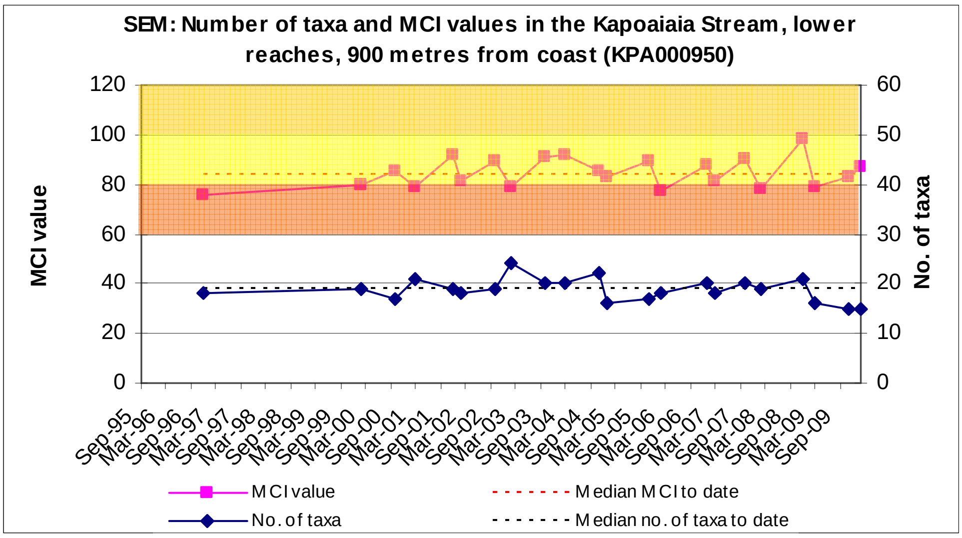


Figure 98 Numbers of taxa and MCI values in the Kapoaiaia Stream at the Cape Egmont (upstream of coast) site

A moderate range of richnesses (16 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 2009-2010 period, spring (15 taxa) and summer (15 taxa) richnesses were identical and lower than the median taxa number on both occasions coincident with patchy (spring) to widespread (summer) substrate periphyton cover and higher water temperatures at the time of the summer survey.

MCI scores have had a moderate range (22 units) at this site, slightly narrower than typical of sites in the lower reaches of ringplain streams. However, the median value (84 units) has been relatively typical of lower reach sites elsewhere on the ringplain. The spring, 2009 (83 units) and summer, 2010 (87 units) scores were typical for such a site and within 3 units of the historical median. These scores categorised this site as having 'fair' (spring) and 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health on both occasions for the lower reaches of a ringplain stream. The historical median score (84 units) placed this site in the 'fair' category for generic and 'expected' category for predictive methods of assessment.

3.2.21.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 103.

Table 103 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kapoaiaia Stream at the site upstream of the coast between 1995 and February 2009 [20 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
PLATYHELMINTHES	*Cura*	3	1	5		
NEMERTEA	Nemertea	3	1	5		
ANNELIDA	Oligochaeta	1	20	100		A
	Lumbricidae	5	1	5		
MOLLUSCA	*Potamopyrgus*	4	12	60	VA	A
EPHEMEROPTERA	*Deleatidium*	8	1	5		
COLEOPTERA	Elmidae	6	13	65	A	VA
TRICHOPTERA	*Aoteapsyche*	4	15	75	VA	VA
	Costachorema	7	1	5		
	Hydrobiosis	5	15	75		
	Oxyethira	2	5	25		
	Pycnocentrodes	5	8	40		A
DIPTERA	*Aphrophila*	5	5	25		
	Chironomus	1	1	5		
	Maoridiamesa	3	10	50	XA	A
	Orthocladiinae	2	20	100		VA
	Tanytarsini	3	4	20		
	Muscidae	3	2	10		
	Austrosimulium	3	6	30		

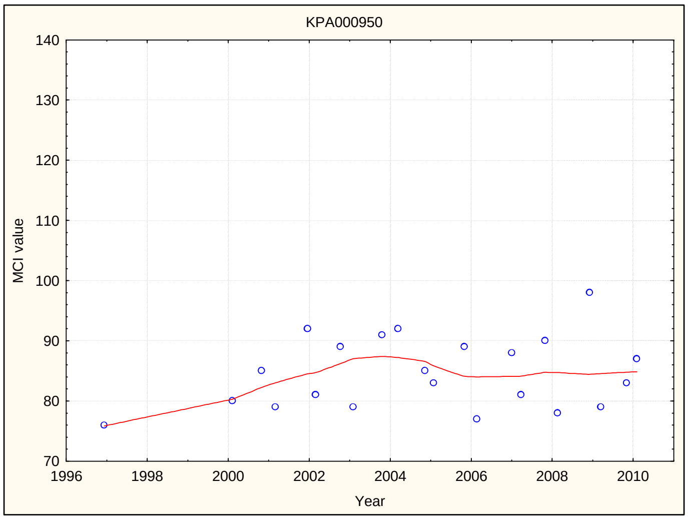
Prior to the current 2009-2010 period 19 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', six 'moderately sensitive', and twelve 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as might be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly sensitive' taxa; three 'moderately sensitive' taxa (elmid beetles, free-living caddisfly (*Hydrobiosis*), and stony-cased caddisfly (*Pycnocentrodes*)); and six 'tolerant' taxa (oligochaete worms (on every occasion), snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), midges (orthoclads (on every occasion) and *Maoridiamesa*), and sandfly (*Austrosimulium*)). Four of the historically characteristic taxa were dominant in the spring 2009 community. These comprised one 'moderately sensitive' and three 'tolerant' taxa, whereas two 'moderately sensitive' and five 'tolerant' taxa comprised the dominant taxa in the summer community. Four of these seven taxa were dominant in both spring and summer communities (Table 103). Similar seasonal proportional dominances by 'tolerant' taxa resulted in minimal difference in seasonal $SQMCI_s$ scores (Table 166 and 167). The five taxa recorded as very or extremely abundant during spring and summer had characterized this site's communities on 50% to 100% of past surveys.

3.2.21.3.3 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 site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 86 (altitude) and 96 (distance) for this site. The historical site median (84 units) is within two units of the altitude prediction but a significant (Stark, 1998) 12 units lower than the distance predictive value. The spring, 2009 survey score (83 units) was below these predictive values and significantly less than the predictive distance value. The summer, 2010 score (87 units) was within 9 units of predictive values. Of the 22 surveys to date at this site, 59% of MCI scores have been less than 86 units while only 5% have been greater than 96 units.

3.2.21.3.4 Temporal trends in 1995 to 2010

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the SEM results collected to date from the site in the Kapoaiaia Stream at near the coast. The MCI has been chosen as the preferable indicator of'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 99.



N = 22
Kendall tau = +0.101
p level = 0.509 [>FDR, p = 0.662]
N/S at $p < 0.05$

Figure 99 LOWESS trend plot of MCI data for the site upstream of the coast

No statistically significant temporal trend was found for the overall monitoring period despite a steady increase in MCI scores over the initial seven year period. There has been a similar trend at the mid-catchment site at Wataroa Road. However, there has been an ecologically significant range (of 11 units) in LOWESS-smoothed MCI scores, influenced by the low initial score, but not as wide as the range at the nearest upstream site. Subsequent to the 1997 survey, no usage of the Pungarehu Dairy Factory (between the two sites) has occurred and there has been a narrower, ecologically insignificant, range of MCI scores (7 units). However more recently there has been an increase in water abstraction in the lower reaches for irrigation purposes.

Smoothed MCI scores have consistently been indicative of 'fair' generic stream health (Table 1) although individual scores have occasionally indicated 'poor' health, invariably under summer, warmer and lower flow conditions. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, health remained in the 'expected' category almost throughout the period.

3.2.21.4 Discussion

Seasonal MCI values atypically improved between spring and summer at two sites (Wiremu Road and near the coast) by 6 and 4 units respectively, while at the Wataroa Road site a more typical summer decrease in MCI score (6 units) was recorded. Seasonal communities shared 62% of the 26 taxa found at the upper mid-reach (Wiremu Road) site, 47% of 32 taxa at Wataroa Road, and 58% of 19 taxa at the furthest downstream site in the lower reaches near the coast, indicative of increased dissimilarity in seasonal community composition at the mid-reach, Wataroa Road site.

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 40 units in spring and 42 units in summer, over a river distance of 19.5 km. These seasonal falls in MCI scores equated to rates of decline of 2.05 units/km (spring) and 2.15 units/km (summer), much greater than the predicted rate of 0.8 unit/km for the equivalent length and reach of a National Park-sourced stream (Stark and Fowles, 2009). In terms of seasonal rates, this was more typical of the trend of past summer increases in rates of decline.

Between the upper mid-reach site (Wiremu Road) and Wataroa Road mid-reach site, the spring (2.8 units/km) and summer (4.4 units/km) rates of decline were both far higher than the predicted rate (1.2 units/km) for the equivalent stream reach. For the Wataroa Road mid-reach site to lower reach site near the coast, spring (1.5 units/km) and summer (0.7 unit/km) rates of decline were far higher and very similar respectively to the predicted rate of 0.6 unit/km.

Using the long-term median SEM MCI scores for each site (Appendix II), the rates of decline between upper mid-reach (Wiremu Road) and Wataroa Road mid-reach sites, and the Wataroa Road mid-reach site and lower reach site near the coast have been about 1.8 and 0.6 units per km respectively with an overall average rate of decline of 1.1 MCI units/km over the surveyed length. Therefore rates of MCI decline over the 2009-2010 period were higher than typical rates for the 1995 to 2009 period.

Community composition varied markedly through the upper mid-reach to lower reach length of the stream surveyed. A total of 37 taxa was recorded in spring of which only 11 taxa were present at all three sites (Table 104). These included one 'highly sensitive', six 'moderately sensitive', and four 'tolerant' taxa with only one 'moderately sensitive' taxon (elmid beetles) and two 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*) and midge (*Maoridiamesa*)) abundant at all three sites. A much lower total of 24 taxa was found along the river's length by the summer survey (Table 105) of which only eight taxa were present at all three sites. These were also widespread taxa in spring with the addition of one ‘tolerant’ (snail) taxon. Only one ‘moderately sensitive’ taxon and one ‘tolerant’ taxon were abundant at all three sites. These dissimilarities in spatial community structure along the surveyed length (upper mid-reaches to lower reaches) of the Kapoaiaia Stream were more pronounced in spring than in summer.

3.2.22 Kurapete Stream

Two sites in this small ringplain seepage-sourced stream, one located immediately upstream of the Inglewood Wastewater Treatment (WWTP) and the other nearly 6 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.

The results of the spring (2009) and summer (2009 – 2010) surveys are presented in Table 168 and Table 169, Appendix 1.

3.2.22.1 Site upstream of Inglewood WWTP (KRP000300)

3.2.22.1.1Taxa richness and MCI

Twenty-nine surveys have been undertaken, between 1995 and February 2009, at this mid-reach, partly shaded site, draining developed farmland, downstream of Inglewood, but immediately upstream of the WWTP. These results are summarised in Table 104, together with the results from the current period, and illustrated in Figure 100.

Table 104 Results of previous surveys performed in the Kurapete Stream upstream of Inglewood WWTP 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to February 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KRP000300	29	14-32	22	80-100	91	24	99	26	103

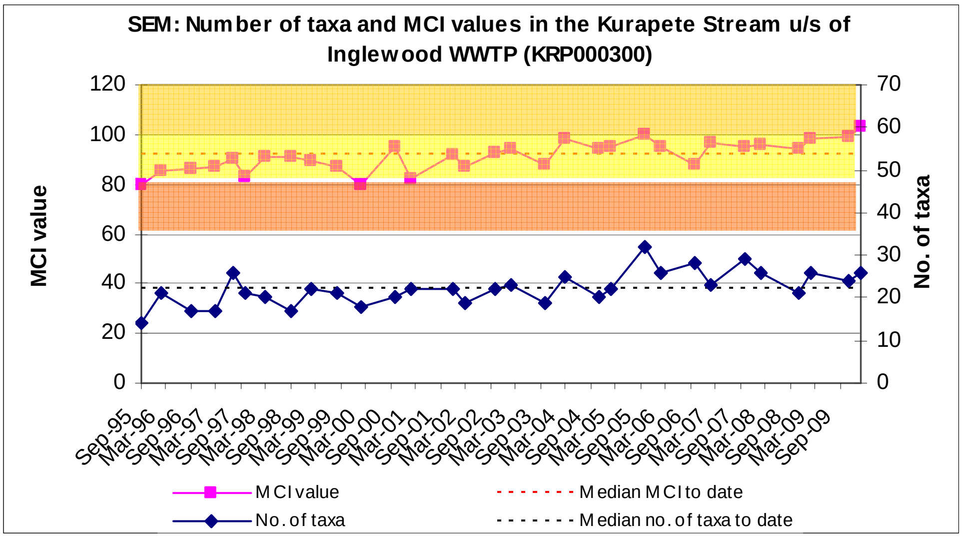


Figure 100 Numbers of taxa and MCI values in the Kurapete Stream upstream of the Inglewood WWTP

A relatively wide range of richnesses (14 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 2009-2010 period spring (24 taxa) and summer (26 taxa) richnesses were two to four taxa higher than this median richness coincident with patchy periphyton layers on the predominantly stony-bouldery substrate of this partially shaded site.

MCI values have had a moderate range (20 units) at this site, typical of mid-reach sites on the ringplain. The historical median value (91 units) also has been typical of mid-reach sites rising outside the National Park elsewhere on the ringplain. The spring, 2009 (99 units) and summer, 2010 (103 units) scores were 7 units and a significant 12 units above the historical median respectively. They categorised this site as having 'fair' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' (spring) and 'better than expected' (summer) health for the mid-reaches of a ringplain stream on these occasions. The historical median score (91 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.22.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 105.

Table 105 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kurapete Stream upstream of Inglewood WWTP, between 1996 and February 2009 [29 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
PLATYHELMINTHES	*Cura*	3	1	3		
NEMERTEA	Nemertea	3	1	3		
ANNELIDA	Oligochaeta	1	22	76		A
MOLLUSCA	*Potamopyrgus*	4	15	52	VA	VA
CRUSTACEA	Paraleptamphopidae	5	3	10		
EPHEMEROPTERA	*Austroclima*	7	10	34	VA	
	Deleatidium	8	1	3		
	Zephlebia group	7	9	31	XA	XA
PLECOPTERA	*Acroperla*	5	2	7		
COLEOPTERA	Elmidae	6	12	41	VA	VA
MEGALOPTERA	*Archichauliodes*	7	7	24	A	A
TRICHOPTERA	*Aoteapsyche*	4	20	69	A	VA
	Hydrobiosis	5	2	7	A	
DIPTERA	*Aphrophila*	5	19	66	A	
	Maoridiamesa	3	3	10		
	Orthocladiinae	2	23	79	A	
	Austrosimulium	3	19	66	A	

Prior to the current 2009-2010 period 17 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', eight 'moderately sensitive', and eight 'tolerant' taxa i.e. a balance between 'sensitive' and 'tolerant' taxa as would be expected in the mid-reaches of a ringplain stream rising outside the National Park.

Predominant taxa have included four 'moderately sensitive' taxa (mayfly (*Austroclima* and *Zephlebia* group), elmid beetles, and cranefly (*Aphrophila*)) and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), orthoclad midges, and sandfly (*Austrosimulium*)).

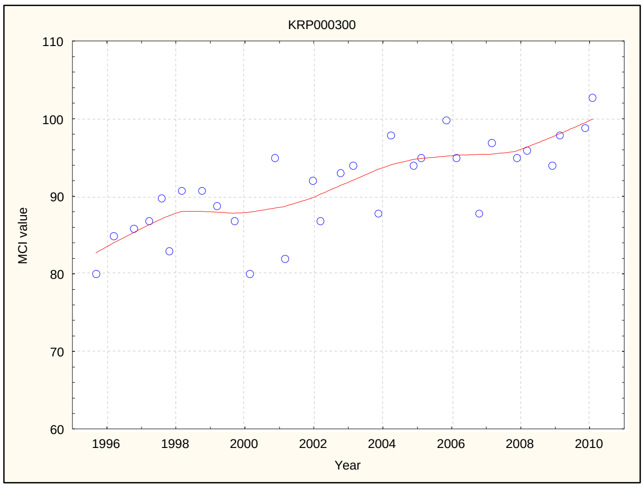
Ten of the historically characteristic taxa were dominant in the spring, 2009 community (Table 105) comprising eight of the predominant taxa (above) together with two of the other 'moderately sensitive' taxa. The summer, 2010 community was characterised by five of the taxa dominant in spring, together with one additional 'tolerant' taxon which previously had been characteristic of this site's communities (Table 105). Despite fewer dominant taxa in summer, the numerically most abundant taxa were relatively similar in both seasons resulting in $SQMCI_s$ scores which were within 0.2 unit (Tables 168 and 169). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 31% to 69% of past surveys.

3.2.22.1.3 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. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 103 units for this site. The historical site median (91 units) is significantly 12 units lower than this altitude prediction while the spring survey score (99 units) and the summer score (103 units) were within 4 units of the predictive value. Of the 31 surveys to date at this site, virtually all (97%) of MCI scores have been less than 103 units, indicating that the current spring and summer MCI scores were less typical of historical conditions.

3.2.22.1.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site, in the Kurapete Stream upstream of the Inglewood WWTP. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 101.



N = 31
Kendall tau = +0.619
p level < 0.0001 [>FDR, p = 0.001]
Significant at p < 0.05 and p < 0.01
and after FDR application

Figure 101 LOWESS trend plot of MCI data at the site upstream of the Inglewood WWTP

The very strong positive temporal trend in MCI scores has been statistically significant at this site 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 trend tended to plateau between 2004 and 2008 with some subsequent improvement, while the overall range of LOWESS-smoothed MCI scores (17 units) has been ecologically significant.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) throughout the period but approaching 'good' health more recently. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain stream, health has remained in the 'expected' category over the fifteen year period although it bordered the 'worse than expected' category prior to 1998 and most recently approached the 'better than expected' category (Figure 101).

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

3.2.22.2.1 Taxa richness and MCI

Twenty-nine 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 February 2009. These results are summarised in Table 106, together with the results from the current period, and illustrated in Figure 102.

Table 106 Results of previous surveys performed in the Kurapete Stream at the site 6km downstream of the Inglewood WWTP outfall, prior to spring 2009, together with spring 2009 and summer 2010 results.

Site code	SEM data (1996 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KRP000660	29	14-30	24	70-103	90	25	100	25	100

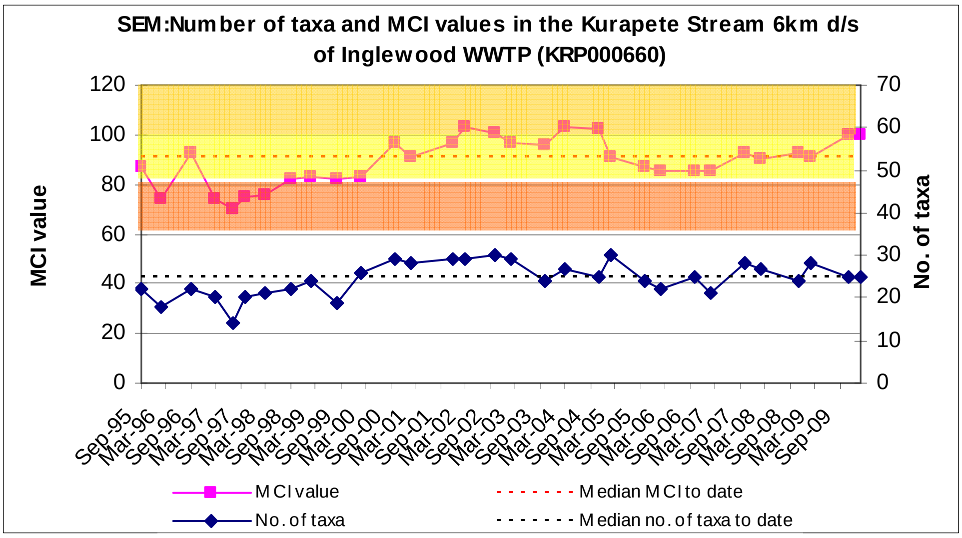


Figure 102 Numbers of taxa and MCI values in the Kurapete Stream, 6 km downstream of the Inglewood WWTP outfall

A moderate range of richnesses (14 to 30 taxa) has been found, with a median richness of 24 taxa (more representative of typical richnesses for the lower mid-reaches of ringplain streams rising outside the National Park boundary (TRC, 1999 (updated, 2009)). During the 2009-2010 period spring (25 taxa) and summer (25 taxa) richnesses were identical and only slightly higher than this median richness.

MCI values have had a moderately wide range (33 units) at this site. The median value (90 units) has been typical of lower mid-reach sites in similar streams elsewhere on the ringplain. The spring, 2009 (100 units) and summer, 2010 (100 units) scores were slightly higher than typical for such a site and 10 units above the historical median score. These scores categorised this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health for the lower mid-reaches of a ringplain stream on both these occasions coincident with improved physicochemical water quality following the diversion of Inglewood WWTP discharges out of the catchment. The historical median score (90 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.22.2.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 107.

Table 107 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 February 2009 [29 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
PLATYHELMINTHES	*Cura*	3	1	3		
NEMERTEA	Nemertea	3	3	10		
NEMATODA	Nematoda	3	1	3		
ANNELIDA	Oligochaeta	1	26	90	A	VA
MOLLUSCA	*Potamopyrgus*	4	15	52	A	A
CRUSTACEA	Ostracoda	1	1	3		
EPHEMEROPTERA	*Austroclima*	7	5	17	A	
	Coloburiscus	7	4	14		
	Zephlebia group	7	5	17	A	VA
PLECOPTERA	*Zelandobius*	5	5	17	A	
COLEOPTERA	Elmidae	6	14	48	A	A
MEGALOPTERA	*Archichauliodes*	7	7	24		
TRICHOPTERA	*Aoteapsyche*	4	15	52	VA	VA
	Costachorema	7	2	7		
	Hydrobiosis	5	12	41		A
	Oxyethira	2	12	41		
	Pycnocentrodes	5	6	21		
DIPTERA	*Aphrophila*	5	20	69	A	
	Maoridiamesa	3	7	24	A	
	Orthocladiinae	2	28	97	A	VA
	Tanytarsini	3	3	10		
	Empididae	3	2	7		
	Muscidae	3	3	10		
	Austrosimulium	3	16	55		

Prior to the current 2009-2010 period, 24 taxa had characterised the community at this site on occasions. These have comprised no 'highly sensitive', ten 'moderately sensitive', and fourteen 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa typical of the lower mid-reaches of a ringplain stream.

Predominant taxa have included three 'moderately sensitive' taxa (elmid beetles, free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)), and six 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), algal-piercing caddisfly (*Oxyethira*), orthoclad midges, and sandfly (*Austrosimulium*)).

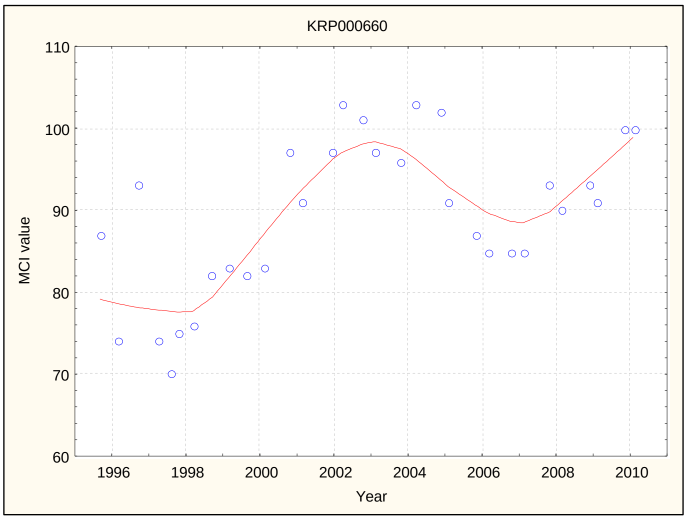
Ten of the historically characteristic taxa were dominant in the spring, 2009 community and comprised eight of the predominant taxa (above) together with three 'moderately sensitive' taxa and one 'tolerant' taxon. The summer, 2010 community was characterised by six of the taxa dominant in spring, together with one additional 'moderately sensitive' taxon which previously had been characteristic of this site's communities (Table 107). The increased abundances in two 'tolerant' taxa in summer was reflected in the small seasonal decrease in $SQMCI_s$ scores of 0.6 unit (Tables 168 and 169). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 17% to 97% of past surveys.

3.2.22.2.3Predicted 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. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 97 units for this site. The historical site median (90 units) is 7 units lower than altitude prediction and both the spring survey score (100 units) and the summer score (100 units) were 3 units higher than the predictive value. Of the 31 surveys to date at this site, 71% of MCI scores have been less than 97 units, indicating that the current spring and summer MCI scores were not typical of historical conditions but 45% of scores have equalled or exceeded 97 units since wastewater discharges were directed out of the stream in 2000.

3.2.22.2.4Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the fifteen years of SEM results collected to date from the site in the Kurapete Stream at at the site 6 km downstream of the Inglewood WWTP outfall. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 103.



N = 31
Kendall tau = +0.375
p level = 0.003 [>FDR, p = 0.014]
Significant at p < 0.05 and after FDR application

Figure 103 LOWESS trend plot of MCI data for the site 6 km downstream of the Inglewood WWTP outfall

A strong positive temporal trend of MCI score improvement, particularly between 1998 and 2003 (following diversion of all Inglewood WWTP wastes out of the stream (to the New Plymouth WWTP)), which was emphasised by an ecologically significant increase in LOWESS-smoothed score of 20 units over this 5 year period. More recently a decreasing trend in scores has been followed by a recovery (since 2007) but the overall statistical significance of the fifteen-year trend has been significant after FDR application coincident with few consented municipal wastes discharge overflows to the stream during recent years.

Overall, the trend of LOWESS-smoothed scores indicated improving stream health from 'poor' through 'fair' approaching 'good' in 2003 and most recently over the 2009-2010 monitoring period. In terms of predictive relationships (Table 2) for a site in the lower mid-reaches of a seepage ringplain stream, health has improved from 'worse than expected' to the 'expected' category over the majority of the period, briefly approaching the 'better than expected' category (in 2003 and most recently), indicative of the effects of diversion of the WWTP discharge out of the stream.

3.2.22.3 Discussion

Seasonal MCI values atypically did not decrease between spring and summer at the two sites, upstream and 6 km downstream of the Inglewood WWTP outfall, where the downstream scores improved by 4 units and /or remained the same. Seasonal communities shared 51% of the 33 taxa common to the mid-reach site and 67% of the 30 taxa common to the downstream, lower mid-reach site indicative of marked seasonal community dissimilarities which decreased in a downstream direction.

MCI score increased by 1 unit in spring and decreased by 3 units in summer between the two sites coincident with the diversion of wastewater discharges from the Inglewood WWTP out of the stream and relatively infrequent consented overflow discharges during the period. These results were more typical of minimal downstream changes recorded by most surveys since 2000. These rates of decline in MCI (0 to 0.5 MCI units/km) were well below the rate expected through the mid reaches of Taranaki ringplain rivers and streams sourced outside of the National Park (TRC, 1999).

Using the long-term median SEM MCI scores for each site (Appendix II), the rate of decline between these mid-reach and lower mid-reach sites has been only 0.2 MCI unit/km over the surveyed length. Therefore rates of MCI decline over the 2009-2010 period were not greatly different in both spring and summer to typical rates for the 1995 to 2009 period.

Community composition varied markedly through the mid-reach to lower mid-reach length of the stream surveyed. A total of 31 taxa was recorded in spring of which 18 taxa were present at both sites. These included two 'highly sensitive', ten 'moderately sensitive', and six 'tolerant' taxa with only the four 'moderately sensitive' taxa and three 'tolerant' taxa abundant at both sites. A higher total of 36 taxa was found along the stream's surveyed length by the summer survey of which fifteen taxa were present at both sites. They were very similar to the widespread taxa in spring with fewer 'moderately sensitive' taxa (e.g. stoneflies). Only five taxa were abundant at both sites in summer; three 'tolerant' taxa and two 'moderately sensitive' taxa. Dissimilarities in spatial community structure along the surveyed length of the Kurapete Stream were more pronounced in summer than spring.

3.2.23 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-pratice diary-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. The two sites are located upstream of the irrigation area (in mid-catchment) and approximately 10 km further downstream toward the lower reaches of the stream. Some consent monitoring data have been collected from the upper site since 2003 but the downstream site was established for biological trend monitoring purposes in the 2008-2009 period.

The results of spring (2009) and summer (2009-2010) surveys are summarized in Tabled 170 and 171, Appendix I.

3.2.23.1Skeet Road site (WKR000500)

3.2.23.1.1Taxa richness and MCI

Nine surveys have been undertaken, between 1996 and March 2009, at this mid-reach, partially shaded site, draining open developed farmland upstream of the Fonterra, Kapuni wastewater irrigation area. These results are summarisd in Table 108, together with the results form the current period, and illustrated in Figure 104.

Table 108 Results of previous surveys performed in the Waiokura Stream at Skeet Road prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1996 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000500	9	20-28	23	88-99	94	21	99	25	104

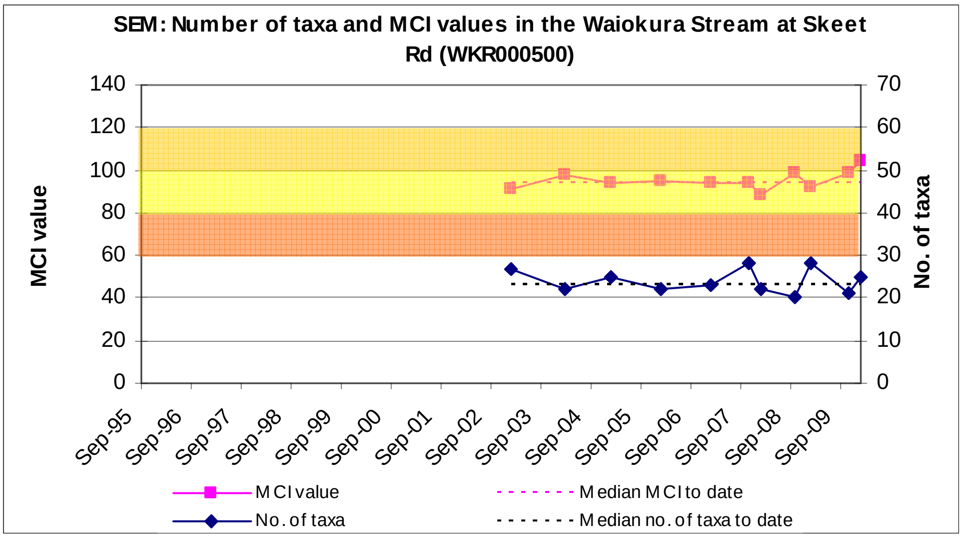


Figure 104 Numbers of taxa and MCI values in the Waiokura Stream at Skeet Road

A moderate range of richnesses (20 to 28 taxa) has been found with a median richness of 23 taxa relatively typical of richnesses in the mid reaches of ringplain streams rising outside the National park boundary. During the 2009-2010 period spring (21 taxa) and summer (25 taxa) richnesses were within two taxa of this median richness coincident with patchy periphyton on the predominantly gravel-cobble substrate of this site in spring and a thinner periphyton layer in summer (after a shorter recession period).

MCI values have had a relatively narrow range (11 units) at this site, atypical of mid reach sites on the ringplain, but the monitoring period has been relatively short to date. The historical median value (94 units) also has been typical of mid-reach sites in streams rising outside the National Park elsewhere on the ringplain, and the spring, 2009 (99 units) and summer, 2010 (104 units) scores were 5 units and 10 units above the historical median respectively, with the latter 5 units above the historical maximum. They categorised this site as having 'fair' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' and 'better than expected' health respectively for the mid-reaches of a ringplain stream on these occasions. The historical median score (94 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.23.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 109.

Table 109 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiokura Stream at Skeet Road, between 2002 and March 2009 [9 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMERTEA	Nemertea	3	1	11		
ANNELIDA	Oligochaeta	1	7	78	A	
MOLLUSCA	*Potamopyrgus*	4	3	33		A
CRUSTACEA	*Paracalliope*	5	1	11		
	Paraleptamphopidae	5	1	11		
EPHEMEROPTERA	*Austroclima*	7	9	100	VA	VA
	Coloburiscus	7	1	11		
	Deleatidium	8	5	56		A
	Zephlebia group	7	2	22	A	
COLEOPTERA	Elmidae	6	9	100	VA	XA
MEGALOPTERA	*Archichauliodes*	7	5	56		A
TRICHOPTERA	*Aoteapsyche*	4	9	100	VA	XA
	Costachorema	7	1	11		
	Hydrobiosis	5	4	44		
	Pycnocentrodes	5	4	44		A
DIPTERA	*Aphrophila*	5	1	11		
	Maoridiamesa	3	2	22		
	Orthocladiinae	2	5	56	A	
	Tanytarsini	3	1	11		

Prior to the current 2009-2010 period 19 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', 11 'moderately sensitive' and seven 'tolerant' taxa i.e. a relatively high proportion of 'tolerant' 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*)); five 'moderately sensitive' taxa (mayfly (*Austroclima*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*), and stony-cased caddisfly (*Pycnocentrodes*)); and four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and orthoclad midges).

Six of the historically characteristic taxa were dominant in the spring, 2009 community comprising five of the predominant taxa (above) together with one other 'moderately sensitive' taxon. The summer, 2010 community was characterised by three of the taxa dominant in spring, together with an additional one 'highly sensitive', two 'moderately sensitive' and one 'tolerant' taxa, all of which previously had been characteristic of this site's communities. Despite increased summer abundances within one 'sensitive' and one 'tolerant' dominant taxa, there was minimal difference in seasonal $SQMCI_s$ scores (0.1 unit) (Tables 170 and 171). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on every past survey occasion (Table 109).

3.2.23.1.3 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. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 100 units for this site. The historical site median (94 units) is 6 units below this altitude prediction while the spring survey score (99 units) and the summer score (104 units) were within 1 to 4 units of the predictive value. Of the 11 surveys to date at this site, 91% of MCI scores have been less than 100 units, indicating that the current summer MCI score was atypical of historical conditions (but the relatively short monitoring period to date should be noted for this site).

3.2.23.1.4 Temporal trends in 2001 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed as the duration of data collection has been insufficient from the site in the Waiokura Stream at Skeet Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data is provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 105.

Figure 105 LOWESS trend plot of MCI data at the Skeet Road site

More recently there has been relatively strong temporal improvement in MCI scores at this site. The LOWESS-smoothed range of MCI scores (11 units) has some ecological significance and 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, but the short duration of monitoring must be noted.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) almost throughout the period but approaching 'good' health more recently. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain stream, health has remained in the 'expected' category over almost the entire seven year period although it most recently entered the 'better than expected' category (Figure 105).

3.2.23.2 Manaia golf course site (WKR000700)

3.2.23.2.1 Taxa richness and MCI

Four surveys have been undertaken at this more recently established lower reach site in the Waiokura Stream at Manaia between 2007 and March 2009. These results are summarised in Table 110 together with the results from the current period, and illustrated in Figure 106.

Table 110 Results of previous surveys performed at Waiokura Stream at Manaia golf course, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (2007 to March 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000700	4	18-26	24	92-97	95	22	103	16	100

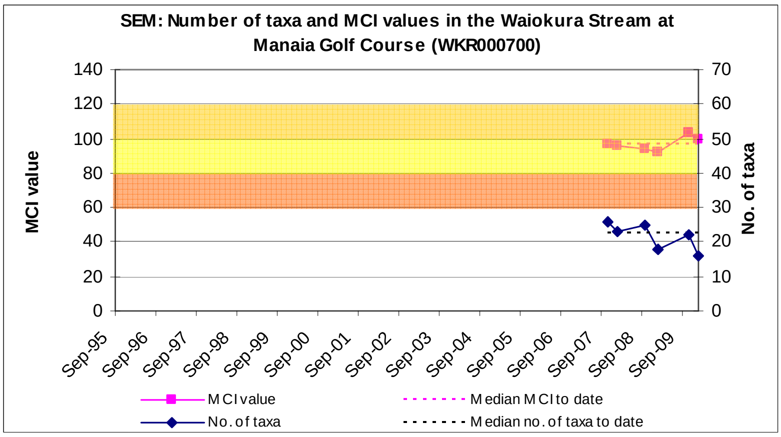


Figure 106 Numbers of taxa and MCI values in the Waiokura Stream at Manaia Golf course

A moderate range of richnesses (18 to 26 taxa) has been found, with a median richness of 24 taxa (more representative of typical richnesses for the lower reaches of ringplain streams rising outside the National Park boundary). During the 2009-2010 period spring (22 taxa) and summer (16 taxa) richnesses were relatively different and lower than this median richness.

MCI values have had a narrow range (5 units) at this site due in part to the very short duration of the monitoring period to date. The median value (95 units) has been slightly higher than typical of lower reach sites elsewhere on the ringplain however. The spring, 2009 (103 units) and summer, 2010 (100 units) scores were also higher than typical for such a site; but insignificantly 8 and 5 units above the historical median respectively. These scores categorised this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health for the lower reaches of a ringplain stream on both these occasions coincident with some riparian cover within the golf course. The historical median score (95 units) placed this site in the 'fair' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.23.2.2Community composition

Characteristic macroinvertebrate taxa in the communties at this site for the short period prior to the 2009-2010 period are listed in Table 111.

Table 111 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiokura Stream at the Manaia golf course, between 2007 and March 2009 [4 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
NEMATODA	Nematoda	3	1	25		
ANNELIDA	Oligochaeta	1	3	75	A	A
MOLLUSCA	*Potamopyrgus*	4	2	50	A	
CRUSTACEA	*Paracalliope*	5	1	25		
EPHEMEROPTERA	*Austroclima*	7	4	100	XA	VA
	Coloburiscus	7	2	50		VA
	Zephlebia group	7	4	100	VA	VA
PLECOPTERA	*Zelandobius*	5	1	25		
COLEOPTERA	Elmidae	6	4	100	VA	VA
MEGALOPTERA	*Archichauliodes*	7	3	75	A	A
TRICHOPTERA	*Aoteapsyche*	4	3	75	A	XA
	Hydrobiosis	5	0	0		A
	Pycnocentrodes	5	1	25		

Prior to the current 2009-2010 period, 12 taxa had characterised the community at this site on occasions. These have comprised no 'highly sensitive', eight '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, coincident with the riparian cover provided within the Manaia golf course.

Predominant taxa have included five 'moderately sensitive' taxa (mayflies (*Austroclima*, *Zephlebia* group and *Coloburiscus*), elmid beetles and dobsonfly (*Archichauliodes*)) and three 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), and net-building caddisfly (*Aoteapsyche*)).

Seven of these historically characteristic taxa were dominant in the spring, 2009 community comprising seven of the predominant taxa (above). The summer, 2010 community was characterised by six of the taxa dominant in spring, together with an additional two 'moderately sensitive' taxa, one of which (free-living caddisfly (*Hydrobiosis*)) previously had not been characteristic of this site's communities (Table 111). The increased summer dominance by one 'tolerant' taxon in particular was reflected in the decrease in seasonal $SQMCI_s$ scores of 1.3 units (Tables 170 and 171). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 50% to 100% of past surveys.

3.2.23.2.3Predicted 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. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 92 units for this site. The short-term historical site median (95 units) is slightly above this altitude prediction coincident with only patchy riparian vegetation cover through the Manaia golf course. Both the spring survey score (103 units) and the summer score (100 units) were higher than this predictive value by up to 8 units. Of the six surveys to date at this site, no MCI scores have been less than 92 units, indicating that the current spring and summer MCI scores were typical of historical conditions although, somewhat better than past scores.

3.2.23.2.4Temporal trends in 2007 to 2010 data

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the four years of SEM results collected to date from the site in the Waiokura Stream at Manaia golf course due to the short duration of the programme to date. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. However a graphical presentation of LOWESS plot of trends in MCI data is provided for this site despite the short period. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 107.

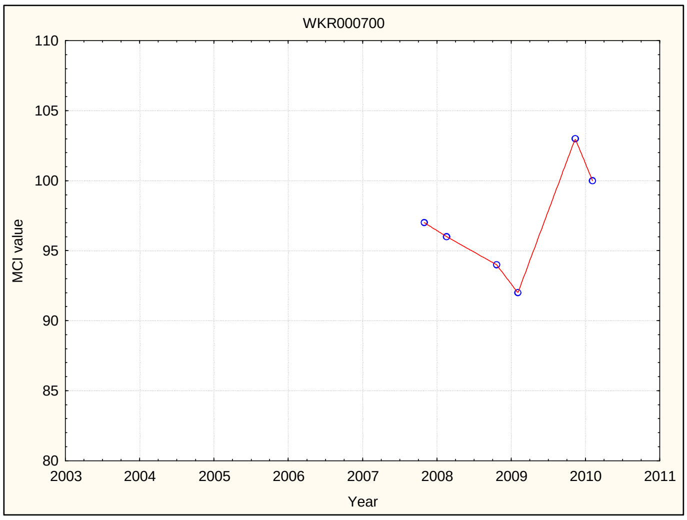


Figure 107 LOWESS trend plot of MCI data for the Manaia golf course

A similar temporal trend of a marked recent improvement in MCI scores to that found at the upstream site (at Skeet Road) was identified at this site at the Manaia golf course. The LOWESS-smoothed range of scores (11 units) has marginal ecological significance and the trend may have been related to the upstream catchment activities noted above (Section 3.2.23.1.4) but the very short duration of the data record must be noted.

The smoothed MCI scores which indicated 'fair' generic stream health (Table 1) for two years of the monitoring period, have improved to 'good' stream health over the recent year. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, health has remained 'better than expected' over the period, further indication of the value of the riparian cover provided through the golf course reach of this stream.

3.2.23.3Discussion

Seasonal MCI values atypically increased (by 5 units) at the mid-reach site and typically decreased (by 3 units) between spring and summer at the site in the lower reaches. Seasonal communities shared 59% of the 29 taxa common at the mid-reach site and 58% of 24 taxa at the downstream site in the lower reaches at Manaia indicative of minimal change in dissimilarities in seasonal community composition in a downstream direction.

Community composition indicated no deterioration at the lower reach site where similar proportions of more higher scoring taxa to those at the mid-reach site were recorded in both spring and summer.

MCI score increased by 5 units in spring but dropped by 3 units in summer between the more open farmland mid-reach site (Skeet Road) and the lower reach Manaia golf course site, coincident with some improved habitat provided by patches of riparian vegetation cover through the golf course. These differences in MCI scores between sites represented a rate of MCI decrease of nil units/km (spring) and 0.3 unit/km (summer), well below the rate expected through the mid to lower reaches of Taranaki ringplain rivers and streams sourced outside of the National Park (TRC, 1999).

Using the longer-term median SEM MCI scores for each site (for the short period 2007 to date), there has been no decline between the mid-reach site at Skeet Road and the lower reach site near Manaia over the surveyed length. Therefore rates of MCI decline (and improvement) over the 2009-2010 period in spring and summer were probably typical of rates for the 2007 to 2009 period.

Community composition varied through the mid reach to lower reach length of the stream surveyed. A total of 27 taxa was recorded in spring of which 16 taxa were present at both sites. These included one 'highly sensitive', ten 'moderately sensitive', and five 'tolerant' taxa with only three 'moderately sensitive' taxa and two 'tolerant' taxa abundant at both sites. A similar total (28 taxa) was found along the stream's surveyed length by the summer survey of which 13 taxa were present at both sites. There were very similar to the widespread taxa in spring with a decrease of two 'moderately sensitive' and one 'tolerant' taxa. Only four taxa were abundant at both sites in summer; one 'tolerant' and three 'moderately sensitive' taxa. Dissimilarities in spatial community structure along the surveyed length (mid to lower reaches) of the Waiokura Stream were more pronounced in summer.

3.2.24 Tangahoe River

Three sites in this eastern hill country river were included in the SEM programme in 2007 for the purpose of monitoring long-term land use changes (aforrestation) particularly in the upper-mid catchment. The Fonterra, Hawera dairy factory abstracts water in the lower catchment for processing purposes. Two of the three sites are in the upper to mid reaches of the river (the upstream site within 4 km of the headwaters) with the third site in the lower reaches.

The results of the spring, 2009 survey are presented in Table 172 and the summer, 2009 – 2010 survey in Table 173, Appendix I.

3.2.24.1Upper Tangahoe Valley Road site (TNH000090)

3.2.24.1.1Taxa richness and MCI

Four surveys have been undertaken at this upper reach site in the Tangahoe River between 2007 and February 2009. These results are summarised in Table 112, together with the results from the current period, and illustrated in Figure 108.

Table 112 Results of previous surveys performed in the Tangahoe River at upper Tangahoe Valley Road, prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000090	4	17-30	25	93-106	100	18	92	24	97

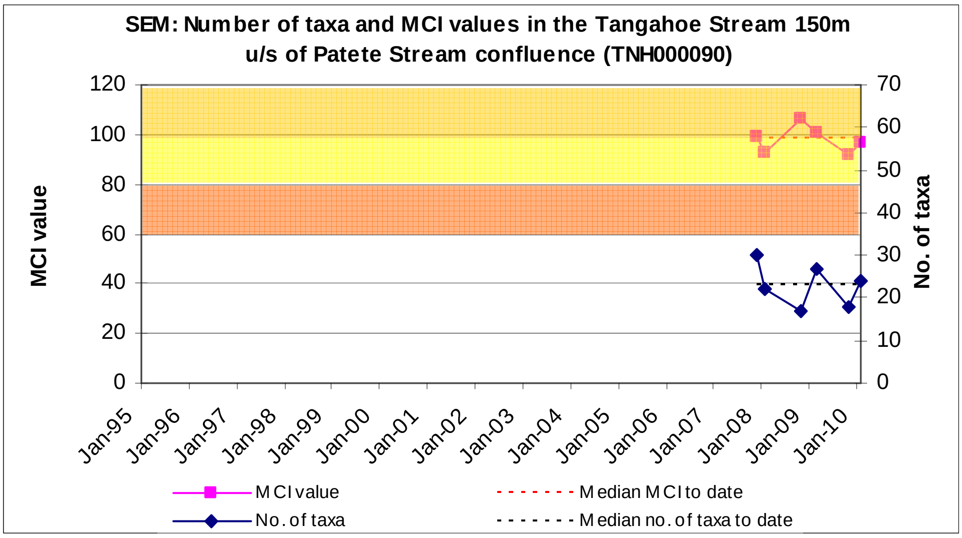


Figure 108 Numbers of taxa and MCI values in the Tangahoe River at Upper Tangahoe Valley Road

A relatively wide range of richnesses (17 to 30 taxa) has been found with a moderate median richness of 25 taxa (lower than typical richnesses in the upper reaches of eastern hill country rivers) but higher than median richness for sites at this relatively low altitude (85 m asl) (TRC, 1999 (updated, 2009)). During the 2009-2010 period, spring (18 taxa) and summer (24 taxa) richnesses were less than this median richness.

MCI values have had a relatively narrow range (13 units) at this site, more typical of a site in the upper reaches of streams and rivers. The median value (100 units) has been more typical of mid reach sites elsewhere and a significant 11 units above the median score recorded by 35 previous surveys at 'control' sites located at similar altitudes (to the upper Tangahoe Valley Road site) in eastern hill country rivers and streams (TRC, 1999 (updated 2009)). The spring, 2009 (92 units) and summer, 2010 (97 units) scores were 3 to 8 units lower than the historical median. These scores categorised this site as having 'fair' health generically (Table 1) in both spring and summer. The historical median score (100 units) places this site on the border of 'good' and 'fair' categories for the generic method of assessment.

3.2.24.1.2Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 113.

Table 113 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Tangahoe River at upper Tangahoe Valley Road between 2007 and February 2009 [4 surveys], and by the spring 2009 and summer 2010 surveys.

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	2	50	A	
MOLLUSCA	*Potamopyrgus*	4	4	100	XA	XA
EPHEMEROPTERA	*Austroclima*	7	4	100	VA	A
	Deleatidium	8	3	75		A
	Zephlebia group	7	1	25	A	A
PLECOPTERA	*Megaleptoperla*	9	1	25		
COLEOPTERA	Elmidae	6	4	100	VA	VA
MEGALOPTERA	*Archichauliodes*	7	1	25		
TRICHOPTERA	*Aoteapsyche*	4	1	25		A
	Hydrobiosis	5	1	25		
DIPTERA	*Austrosimulium*	3	3	75		A

Prior to the current 2009-2010 period, 11 taxa have characterised the community at this site on occasions. These have comprised two 'highly sensitive', five 'moderately sensitive', and four 'tolerant' taxa i.e. a relatively high proportion of 'sensitive' taxa as would be expected in the upper reaches of an eastern hill-country river but taking into account the relatively flat gradient of this river. 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*)). Four of these predominant taxa were dominant in the spring, 2009 community together with one other historically characteristic taxon. The summer, 2010 community was characterised by four of the taxa dominant in spring, together with an additional three taxa; all of which previously had been characteristic of this site's communities (Table 113). Despite several seasonal differences in characteristic taxa, the similarity in the two most numerically dominant taxa in spring and summer surveys was reflected in the minimal difference (0.2 unit) in seasonal SQMCI$_s$ scores (Table 172 and 173). All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on all (four) of the past survey occasions.

3.2.24.1.3Predicted stream 'health'

The Tangahoe River site at upper Tangahoe Valley Road, at an altitude of 85 m asl, is in the upper reaches of this low gradient river draining an eastern hill country catchment. A relationship for ringplain streams and river developed beween MCI and altitude (Stark and Fowles, 2009) is therefore not appropriate for this river.

3.2.24.1.4Temporal trends in 2007 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the three years (2007-2010) of SEM results collected to date from the site in the Tangahoe River at upper Tangahoe Valley Road due to the short duration of the data record. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. However, a graphical presentation of LOWESS plot trends in MCI data is provided for this site. The LOWESS (tension 0.14) trend plot of MCI data is presented in Figure 109.

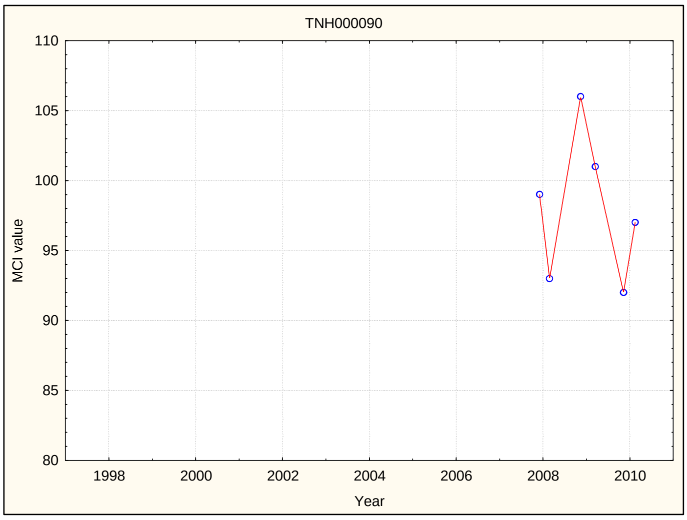


Figure 109 LOWESS trend plot of MCI data for the upper Tangahoe Valley site

No temporal trend in MCI scores may be interpreted for this upper river reach, eastern hill country site due to the short monitoring period to date. The range of LOWESS-smoothed MCI scores (14 units) may be ecologically significant but cannot be fully assessed until the monitoring period is of sufficient duration.

Smoothed MCI scores ranging from 'fair' to 'good' generic river health (Table 1) have been recorded over the three year period (Figure 109).

3.2.24.2Tangahoe Valley Road bridge site (TNH000200)

3.2.24.2.1Taxa richness and MCI

Four surveys have been undertaken at this mid reach site in the Tangahoe River between 2007 and February 2009. These results are summarised in Table 114, together with the results from the current period, and illustrated in Figure 110.

Table 114 Results of previous surveys performed in the Tangahoe River at Tangahoe Valley Road bridge, prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000200	4	23-33	26	92-107	105	20	106	27	108

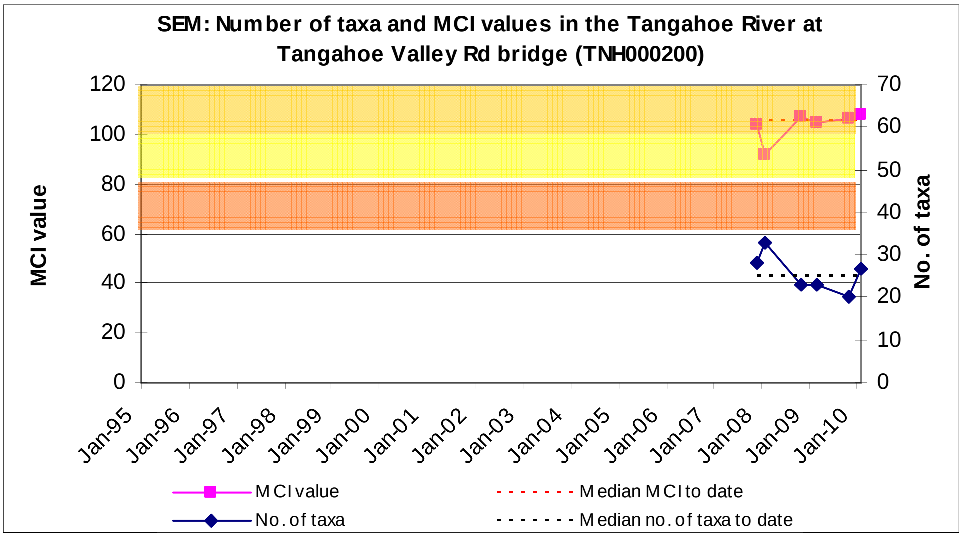


Figure 110 Numbers of taxa and MCI values in the Tangahoe River at Tangahoe Valley Road bridge

A moderate range of richnesses (23-33 taxa) has been found with a relatively good median richness of 26 taxa (typical of richnesses in the mid-reaches of eastern hill country rivers). During the 2009-2010 period, spring richness (20 taxa) was well below median, while summer richness (27 taxa) was very similar to this median taxa number.

MCI values have had a moderate range (15 units) at this site and typical of a site in the mid-reaches of eastern hill country streams and rivers. The median value (105 units) has also been typical of mid-reach sites elsewhere and four units above the median score recorded by 10 previous surveys at 'control' sites located at similar altitudes in eastern hill country rivers and streams (TRC, 1999 (updated, 2009)). The spring, 2009 (106 units) and summer, 2010 (108 units) scores were 1 to 3 units higher than the historical median. These scores categorised this site as having 'good' health generically (Table 1) in both spring and summer. The historical median score (105 units) also placed this site in the 'good' category for the generic method of assessment.

3.2.24.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 115.

Table 115 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Tangahoe River at Tangahoe Valley Road bridge between 2007 and February 2009 [4 surveys], and by the spring 2009 and summer 2010 surveys.

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	2	50		
MOLLUSCA	*Potamopyrgus*	4	3	75	A	
EPHEMEROPTERA	*Austroclima*	7	4	100	VA	VA
	Coloburiscus	7	0	0		A
	Deleatidium	8	2	50	VA	VA
	Rallidens	9	1	25		
	Zephlebia group	7	3	75	VA	VA
PLECOPTERA	*Acroperla*	5	0	0	A	
	Zelandobius	5	2	50		
COLEOPTERA	Elmidae	6	4	100	A	VA
MEGALOPTERA	*Archichauliodes*	7	1	25		A
TRICHOPTERA	*Aoteapsyche*	4	4	100	A	XA
	Hydrobiosis	5	3	75		A
	Oxyethira	2	2	50		
	Pycnocentrodes	5	0	0	A	
DIPTERA	*Aphrophila*	5	3	75		A
	Orthocladiinae	2	4	100		
	Tanytarsini	3	3	75		A
	Austrosimulium	3	2	50		

Prior to the current 2009-2010 period, 16 taxa have characterised the community at this site on occasions. These have comprised two 'highly sensitive', seven 'moderately sensitive', and seven 'tolerant' taxa i.e. a high proportion of 'sensitive' taxa as would be expected in the mid-reaches of an eastern hill-country river. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*); six 'moderately sensitive' taxa ((mayflies (*Austroclima* and *Zephlebia* group), stonefly (*Zelandobius*), elmid beetles, caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)); and seven 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), algal-piercing caddisfly (*Oxyethira*), midges (tanytarsids and orthoclads), and sandfly (*Austrosimulium*))). Six of these predominant taxa were dominant in the spring, 2009 community together with two other taxa which had not been dominant previously. The summer, 2010 community was characterised by five of the taxa dominant in spring, together with an additional five taxa; all but one of which previously had been characteristic of this site's communities (Table 115). The marked increase in summer abundance of one 'tolerant' taxon was reflected in the lower summer $SQMCI_s$ score (by 1.3 units (Tables 172 and 173)). All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 50% to 100% of the past surveys.

3.2.24.2.3 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 an eastern hill country catchment. A relationship for ringplain streams and river developed between MCI and altitude (Stark and Fowles, 2009) is therefore not appropriate for this river.

3.2.24.2.4Temporal trends in 2070 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the three years (2007-2010) of SEM results collected to date from the site in the Tangahoe River at the Tangahoe Valley Road bridge site due to the short period of data record. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. However, a graphical presentation of LOWESS plot trends in MCI data is provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 111.

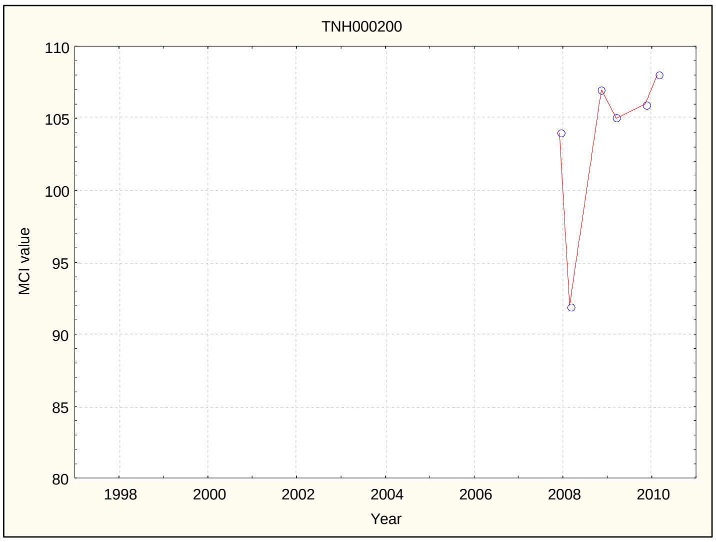


Figure 111 LOWESS trend plot of MCI data for the Tangahoe Valley Road bridge site

No temporal trend in MCI scores may yet be interpreted for this mid river reach, eastern hill country site. The range of LOWESS-smoothed MCI scores (16 units) may have been ecologically significant, but cannot be accurately assessed until the monitoring period is of sufficient duration.

Smoothed MCI scores have mainly indicated 'good' generic river health (Table 1) over the three year period.

3.2.24.3Site downstream of railbridge (TNH000515)

3.2.24.3.1Taxa richness and MCI

Five surveys have been undertaken at this lower reach site in the Tangahoe River between 1995 and March 2009 with four of these surveys since 2007. These results are summarised in Table 116, together with the results from the current period, and illustrated in Figure 112.

Table 116 Results of previous surveys performed in the Tangahoe River d/s of railbridge, prior to the spring 2009 survey, together with spring 2009 and summer 2010 results

Site code	SEM data (1995 to Feb 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000515	5	13-23	16	84-96	88	17	104	26	92

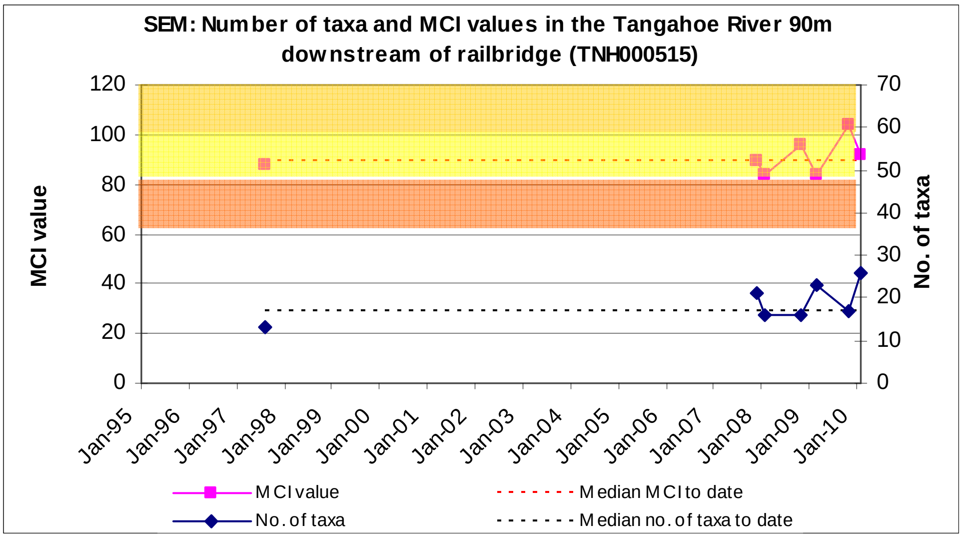


Figure 112 Numbers of taxa and MCI values in the Tangahoe River downstream of the railbridge

A moderate range of richnesses (13 to 23 taxa) has been found with a typical median richness of 16 taxa for a site in the lower reaches of an eastern hill country river. During the 2009-2010 period, spring (17 taxa) and summer (26 taxa) richnesses were above this median richness, particularly in summer when taxa number exceeded the previous maximum (although only six previous surveys had been undertaken).

MCI values also have had a moderate range (12 units) at this site, less typical of a site in the lower reaches of streams and rivers but reference is made also to the relatively short monitoring period at this site. The median value (88 units) has been more typical of lower reach sites elsewhere and equivalent with the median score recorded by 35 previous surveys at 'control' sites located at similar altitudes (to this site) in eastern hill country rivers and streams (TRC, 1999 (updated, 2009)). The spring, 2009 (104 units) and summer, 2010 (92 units) scores were a significant 16 units, and 4 units higher than the historical median respectively. The spring MCI score was 8 units above the historical (short-term) median. These scores categorised this site as having 'good' and 'fair' health generically (Table 1) in spring and summer respectively. The historical median score (88 units) placed this site in the'fair' category for the generic method of assessment.

3.2.24.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 117.

Table 117 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Tangahoe River d/s of the railbridge between 1995 and February 2009 [5 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	4	80	A	A
MOLLUSCA	*Latia*	5	1	20	A	
	Potamopyrgus	4	5	100	XA	A
COLEOPTERA	Elmidae	6	4	80	VA	VA
TRICHOPTERA	*Aoteapsyche*	4	4	80	A	XA
	Pycnocentrodes	5	1	20	VA	
DIPTERA	*Aphrophila*	5	2	40		A
	Maoridiamesa	3	1	20		A
	Orthocladiinae	2	4	80		A
	Austrosimulium	3	1	20		

Prior to the current 2009-2010 period, relatively few (10) taxa have characterised the community at this site on occasions due in part to the short duration of monitoring at this site. These have comprised no 'highly sensitive', four 'moderately sensitive', and six '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 two 'moderately sensitive' taxa (elmid beetles and cranefly (*Aphrophila*)); and four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and orthoclad midges). Four of these predominant taxa were dominant in the spring, 2009 community together with two other historically characteristic taxa. The summer, 2010 community was characterised by fewer of the taxa dominant in spring, together with an additional three taxa; all of which previously had been characteristic of this site's communities (Table 117). Despite several seasonal differences in characteristic taxa, the extreme numerical abundance of one 'tolerant' taxon in spring and summer surveys (although different taxa but with identical sensitivity scores) was reflected in the minimal difference (0.2 unit) in seasonal $SQMCI_s$ scores (Tables 172 and 173). All taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 20% to 100% of the past surveys.

3.2.24.3.3 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 an eastern hill country catchment. A relationship for ringplain streams and river developed between MCI and altitude (Stark and Fowles, 2009) is therefore not appropriate for this river.

3.2.24.3.4 Temporal trends in 1995 to 2010 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the mainly three years of SEM results collected to date from the site in the Tangahoe River downstream of the railbridge due to the small data record. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. However, a graphical presentation of LOWESS plot trends in MCI data is provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 113.

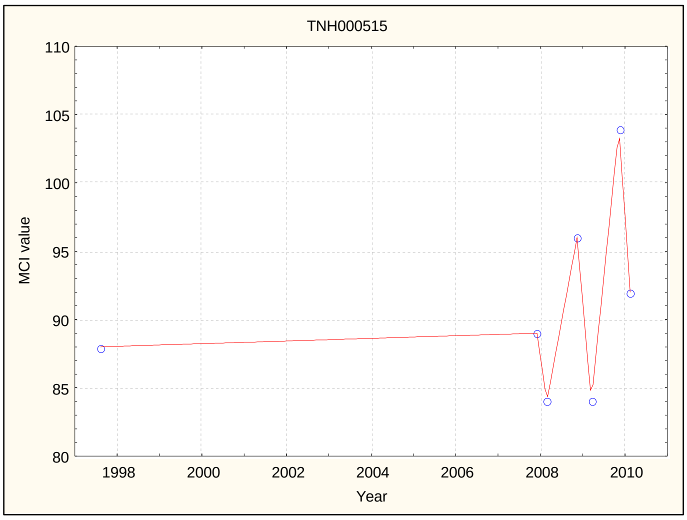


Figure 113 LOWESS trend plot of MCI data for the Tangahoe River site downstream of the railbridge

No temporal trend in MCI scores may yet be inferred from this lower river reach, eastern hill country site. The range of LOWESS-smoothed MCI scores (20 units) has been ecologically significant but this significance cannot be properly assessed until the monitoring period is of sufficient duration for valid interpretation.

Smoothed MCI scores have mainly indicated 'fair' generic river health (Table 1) over the short period (Figure 113).

3.2.24.4Discussion

Seasonal MCI values atypically improved between spring and summer at two sites (Upper Tangahoe Valley Road and Tangahoe Valley Road bridge) by 5 and 2 units respectively, while at the railbridge site in the lower reaches, a more typical summer decrease in MCI score (12 units) was recorded. Seasonal communities shared 45% of the 20 taxa found at the upper reach (Upper Tangahoe Valley Road) site, 52% of 31 taxa at Tangahoe Valley Road bridge, and 54% of 28 taxa at the furthest downstream site in the lower reaches (railbridge), indicative of increased downstream similarity in seasonal community compositions somewhat atypical of downstream trends elsewhere.

The spring MCI scores atypically by 14 units in a downstream direction over the 8.9 km reach between the upper and mid sites, but also increased (by 12 units) between the upper and lower sites over a distance of 30.2 km (and decrease in elevation of 70 m). This trend was atypical of the average rate of decrease of 1.7 units/10 m assessed for large hill country catchments (TRC, 2006c). Summer MCI scores decreased overall between the upper and lower reach sites (by 5 units) representing a rate of decrease of 0.2 MCI unit/km or 0.7 MCI unit/10 m, the latter lower than the average of 1.7 units/10 m assessed for large hill country catchments (TRC, 2006c).

Using the long-term median SEM MCI scores for each site (Appendix II), there has been no decline between upper reach (Upper Tangahoe Valley Road) and mid-reach sites (Tangahoe Valley Road bridge). The rate of decline between the mid-reach site and lower reach (railbridge) site has been about 0.8 unit per km with an overall average rate of decline of 0.3 MCI unit/km over the surveyed length of the river. Therefore rates of MCI decline over the 2009-2010 period were lower than typical rates for the short monitoring period prior to 2009.

Community composition varied markedly through the upper reach to lower reach length of the stream surveyed. A total of 29 taxa was recorded in spring of which only 8 taxa were present at all three sites (Table 110). These included five 'moderately sensitive' and three 'tolerant' taxa with only one 'moderately sensitive' taxon (elmid beetles) and one 'tolerant' taxon (snail (*Potamopyrgus*)) abundant at all three sites. A higher total of 37 taxa was found along the river's length by the summer survey (Table 111) of which thirteen taxa were present at all three sites. These included seven of the widespread taxa in spring with the addition of one 'highly sensitive', one 'moderately sensitive', and three 'tolerant' taxa. Only one 'moderately sensitive' taxon and one 'tolerant' taxon were abundant at all three sites. These dissimilarities in spatial community structure along the surveyed length (upper reaches to lower reaches) of the Tangahoe River were more pronounced in spring than in summer.

3.2.25 Herekawe Stream

One site in this small coastal ringplain stream on the western perimeter of New Plymouth City was included in 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 has been performed at this 'control' site in spring and summer throughout the period from 1995 to 2008 (and dates back to 1986).

The results found by the 2009-2010 surveys are presented in Table 174 and Table 175, Appendix I for this small lowland stream.

3.2.25.1 Centennial Drive site (HRK000085)

3.2.25.1.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken in this lower-reach site in the Herekawe Stream between February 1995 and March 2009. These results are summarised in Table 118, together with the results from the current period, and illustrated in Figure 114.

Table 118 Results of previous surveys performed in Herekawe Stream at Centennial Drive, prior to spring 2009, together with spring 2009 and summer 2010 results

Site code	SEM data (1998 to Mar 2009)					2009-2010 surveys			
	No of surveys	Taxa numbers		MCI values		Dec 2009		Mar 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HRK000085	28	13-23	18	68-96	87	20	84	20	90

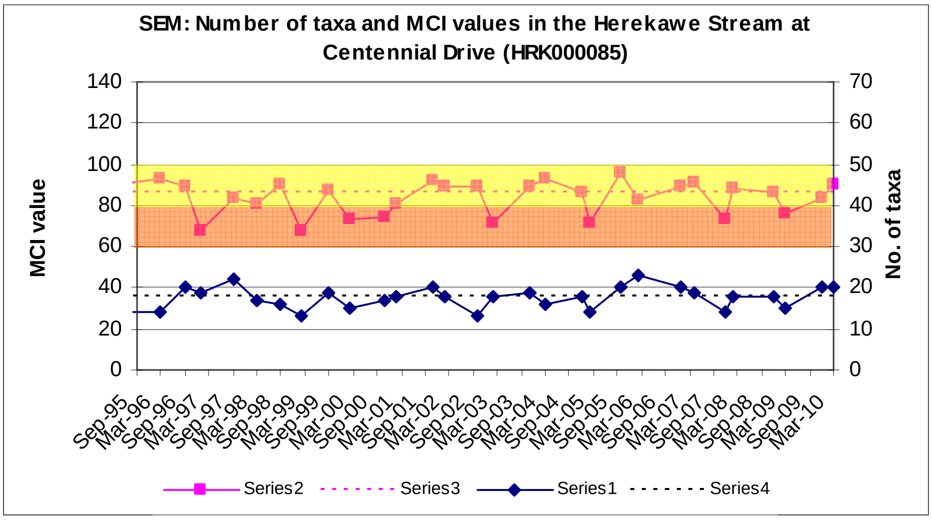


Figure 114 Numbers of taxa and MCI values in the Herekawe Stream upstream of Centennial Drive

A moderate range of richnesses (13 to 23 taxa) has been found, with a median richness of 18 taxa (more representative of typical richnesses in small coastal ringplain streams where a median richness of 16 taxa has been recorded from 200 previous surveys of 'control' sites at similar altitudes (TRC, 1999 (updated, 2009)). During the 2009-2010 period, spring (20 taxa) and summer (20 taxa) richnesses were identical and two taxa higher than this median richness.

MCI values have had a relatively wide range (28 units) at this site. The median value (87 units) has been typical of lower reach sites elsewhere on the ringplain however, and the spring, 2009 (84 units) and summer, 2010 (90 units) scores were typical for such a site. These were within 3 units of the historical median on both occasions. These scores categorised this site as having 'fair' (spring and summer) health generically (Table 1) and the summer score was significantly higher (Stark, 1998) than the median MCI score (75 units) recorded by 200 previous surveys of 'control' sites below 25 m asl in small, coastal ringplain streams in Taranaki (TRC, 1999 (updated, 2009)). The historical median score (87 units) placed this site in the 'fair' category for the generic method of assessment and was also significantly higher than the median score recorded at similar sites elsewhere.

3.2.25.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2009-2010 period are listed in Table 119.

Table 119 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Herekawe Stream at Centennial Drive between 1998 and March 2009 [28 surveys], and by the spring 2009 and summer 2010 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2009	Summer 2010
ANNELIDA	Oligochaeta	1	17	61	A	A
MOLLUSCA	*Potamopyrgus*	4	28	100	VA	XA
CRUSTACEA	Ostracoda	1	2	7		
	Paracalliope	5	22	79	VA	XA
EPHEMEROPTERA	*Austroclima*	7	2	7		
	Coloburiscus	7	1	4		A
PLECOPTERA	*Acroperla*	5	1	4		
TRICHOPTERA	*Oxyethira*	2	8	29		A
	Triplectides	5	10	36		VA
DIPTERA	*Aphrophila*	5	2	7		
	Orthocladiinae	2	16	57	A	
	Austrosimulium	3	11	39		A

Prior to the current 2009-2010 period, 12 taxa had characterised the community at this site on occasions. These have comprised six 'moderately sensitive' and six 'tolerant' taxa i.e. an absence of 'highly sensitive' taxa and a relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream.

Predominant taxa have included only two 'moderately sensitive' taxa (amphipod (*Paracalliope*), and vegetation-cased caddisfly (*Triplectides*)) and four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), orthoclad midges and sandfly (*Austrosimulium*)).

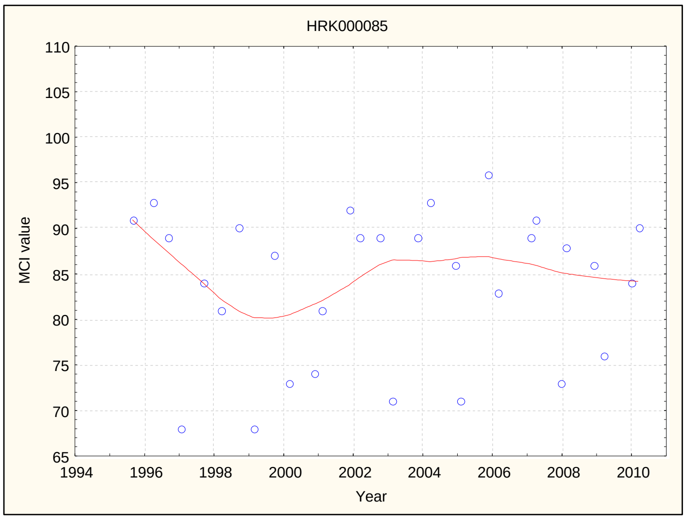
Four of the historically characteristic taxa were dominant in the spring, 2009 community and were comprised of four of the predominant taxa (above). The summer, 2010 community was characterised by three of the taxa dominant in spring, together with an additional two 'moderately sensitive' and two 'tolerant' taxa, one of which previously had been predominantly characterisctic of this site's communities (Table 119). An increase in numerical abundances in two individual dominant 'sensitive' taxa in the summer survey was reflected in the relatively small increase in $SQMCI_s$ score (0.5 unit) between seasons (Tables 174 and 175). All taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 36% to 100% of past surveys.

3.2.25.1.3 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. Relationshps for ringplain streams developed between MCI and distance from the National Park or site altitude (Stark and Fowles, 2009), therefore are not applicable in this type of small lowland coastal stream.

3.2.25.1.4 Temporal trends in 1995 to 2010 data

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the SEM results collected to date from the site in the Herekawe Stream at Centennial Drive. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of LOWESS plot of trends in MCI data and Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 115.



N = 30
Kendall tau = +0.009
p level = 0.9.42 [>FDR, p = 0.960]
N/S at $p < 0.05$ level

Figure 115 LOWESS trend plot of MCI data at the Centennial Drive site

The very slightly positive temporal trend in MCI scores was not statistically significant at this site in the lower reaches of the stream immediately downstream of the recently constructed walkway. Trends have varied at this site over the fifteen year period with wide variation in individual MCI scores although the range of LOWESS-smoothed scores (11 units) has only just been ecologically significant.

Smoothed MCI scores have consistently remained indicative of 'fair' stream health throughout the monitoring period.

3.2.25.2 Discussion

Seasonal MCI values atypically increased between spring and summer (but only by 6 units) at this lower reach site. The percentage composition of 'tolerant' taxa atypically decreased by 5% in the summer community when filamentous algal substrate cover was similar but under slightly warmer water temperature conditions. Seasonal communities at this site shared 15 common taxa (60% of the 25 taxa found at this site in 2009-2010)), a relatively high percentage of common taxa thereby resulting in the small seasonal difference of 6 units in MCI values.

4. General discussion and conclusions

In general, 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., 10 years of spring and summer surveys. With fifteen years of data available, temporal trend analyses have been updated within this report. Other comments in relation to the data collected in the period 1995 to 2010, are presented briefly below. These data are summarised in Appendix II and illustrated in Figures 116 to 122.

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 organic pollution than proportions which comprised the sites' communities in the mid and lower reaches of catchments. These changes in community composition resulted from the effects of organic enrichment, higher temperatures, finer substrate, and increased algal growth in the lower reaches of streams and rivers.

Trends in taxa richnesses 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 more recent headwater erosion events) but more seasonal variability in richnesses further downstream. Summer richnesses have tended to be higher than spring richnesses, particularly at lower reach sites.

Overall, sites in the middle and particularly the lower reaches of streams and rivers have had lower summer MCI scores than spring MCI scores. This trend has been coincident with warmer water temperatures and increased periphyton substrate cover, resulting in the loss or replacement of certain 'sensitive' taxa by lower scoring 'tolerant' taxa. However, few sites have shown significant seasonal differences (on the basis of the detectable differences of Stark (1998) over the 1995-2010 period. Furthermore, the results from the 2009-2010 period have shown that:

- over all sites, spring MCI scores were only slightly higher than summer scores but t-testing of the mean seasonal MCI difference (1 MCI unit) showed that this was insignificant ($p = 0.78$)
- at mid reach sites, a decrease in average MCI score of 2 units in summer was insignificant ($p = 0.65$)
- at lower reach sites, a very slight decrease in average MCI of 0.3 unit in summer was also insignificant ($p = 0.89$)
- at all sites, spring 2009 MCI scores were on average 3.6 units higher than long term (fourteen year) median scores, but this difference was insignificant ($p = 0.26$)
- at all sites, summer 2010 MCI scores were on average, 3 units higher than long term (fourteen year) median scores, but t-tests showed that this difference was insignificant ($p = 0.34$).

4.1.1 Spring surveys

4.1.1.1 Historical SEM

Forty-nine (of the 57) sites' faunal communities' MCI scores were either similar to, or better than, historical SEM medians for those sites (Figure 116). Significantly higher scores were found at nine sites which were situated in the upper reaches of the Kapoaiaia Stream, mid reaches of the Mangawhero and Kaupokonui Streams, and in the lower reaches of the Mangaoraka, Timaru, and Punehu Streams, and Mangaehu and Tangahoe Rivers coincident with lower reach sites having reduced periphyton cover in comparison with past surveys. Significantly lower scores were found at only one site, in the upper Waiwhakaiho River (during the recovery phase from a recent headwater erosion event).

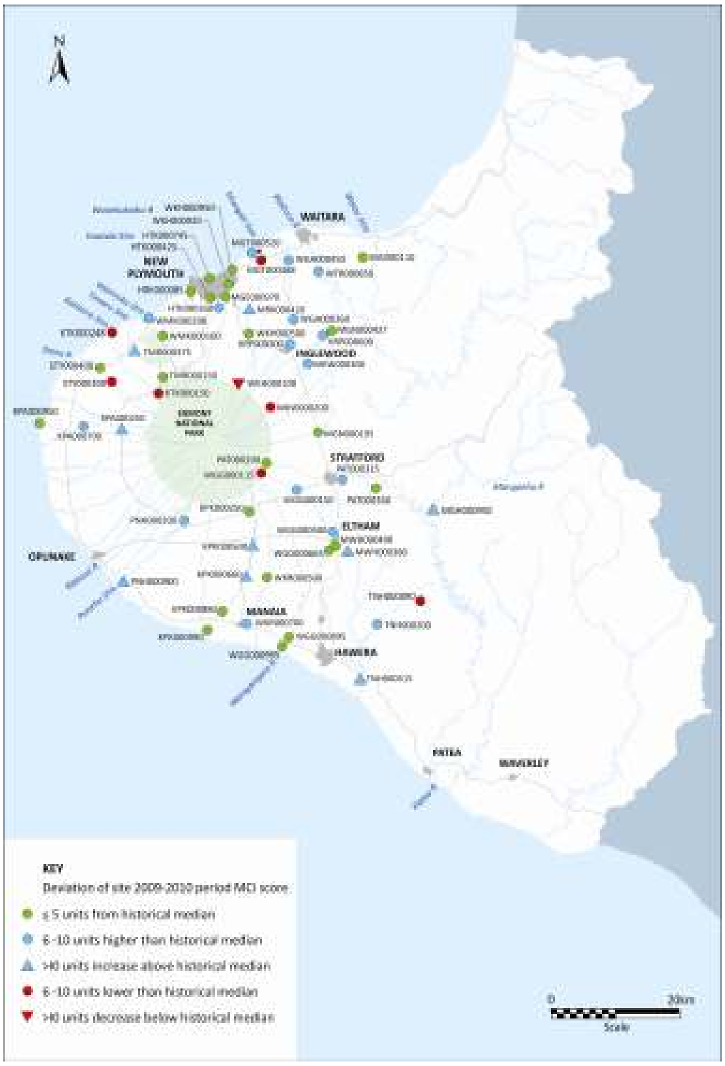


Figure 116 Spring 2009 MCI scores in relation to SEM historical median values

In summary, 82% of sites showed no significant detectable differences (Stark, 1998) between spring, 2009 MCI scores and historical median scores, while 16% of sites had significantly higher spring 2009 MCI scores.

4.1.1.2 Predictive TRC ringplain altitude/distance models

Predictive scores have been developed for ringplain sites in relation to altitude and distance from the National Park (Stark and Fowles, 2009). Spring scores for each ringplain site have been assessed against predicted scores for altitude in Figure 117 and against predicted scores for distance from the National Park boundary for ringplain sites with their sources inside the National Park in Figure 118.

4.1.1.2.1 Altitude

Few (five) sites had spring MCI scores more than 5 units below predicted values (Figure 117), four of which (Patea River at Skinner Road (downstream of StratfordWWTP), upper (erosion affected) reach of the Waiwhakaiho River, upper reach of the Waingongoro River, and lower reach of the Mangawhero Stream (below the Eltham WWTP discharge)) were significantly lower than predicted. Sixteen sites had spring scores very similar to (within 5 units) of predicted scores while the remaining 26 sites' scores were more than 5 MCI units above predicted scores for sites at equivalent altitudes. Of the latter, fourteen sites had significantly higher MCI scores. These sites were situated in the upper reaches of the Waimoku, Kapoaiaia and Punehu Streams; mid-reaches of the Manganui and Waingongoro Rivers and the Huatoki and Kaupokonui Streams; and lower reaches of the Mangaoraka, Timaru, Katikara, Waiokura, and Punehu Streams and Stony River.

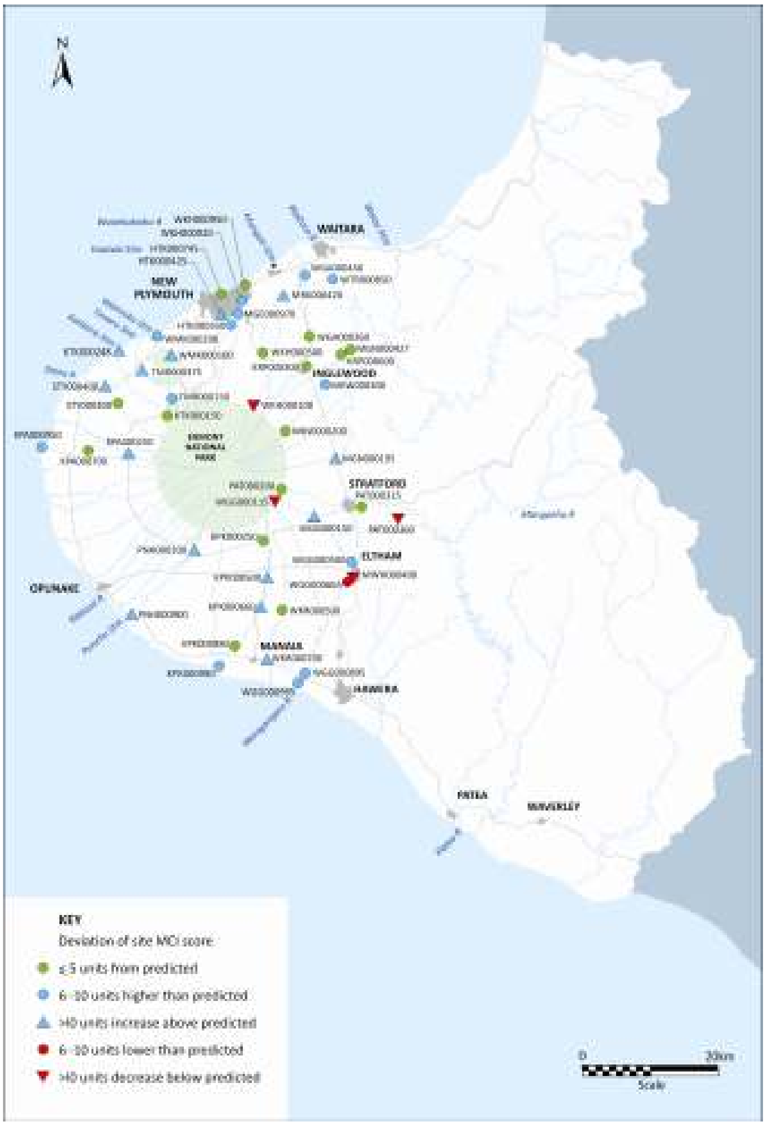


Figure 117 Spring 2009 MCI scores in relation to predicted altitude scores

In summary, 62% of sites showed no significant detectable difference (Stark, 1998) between spring, 2009 scores and predicted altitude scores, while 30% of sites had significantly higher spring, 2009 MCI scores and 8% of sites had significantly lower spring, 2009 scores.

4.1.1.2.2 Distance from National Park

Only three sites had spring MCI scores more than 5 units below predicted values (Figure 118) with two of these sites significantly lower than predicted. These sites were in the Waimoku Stream at the coast (due to the very short distance between the source and the coast) and the upper (erosion affected) reaches of the Waiwhakaiho River. Seventeen sites had spring scores within 5 MCI units of predicted scores while eighteen sites' scores were more than 5 units higher than predicted. There were twelve sites with scores significantly higher than predicted, two of which were in the mid reaches of the Kaupokonui Stream and the Waingongoro River. The other sites were located in the upper reaches of the Timaru, Kapoaiaia, and Punehu Streams; mid reaches of the Waingongoro, Patea, and Manganui Rivers; and in the lower reaches of the Waingongoro, Waiwhakaiho, and Manganui Rivers.

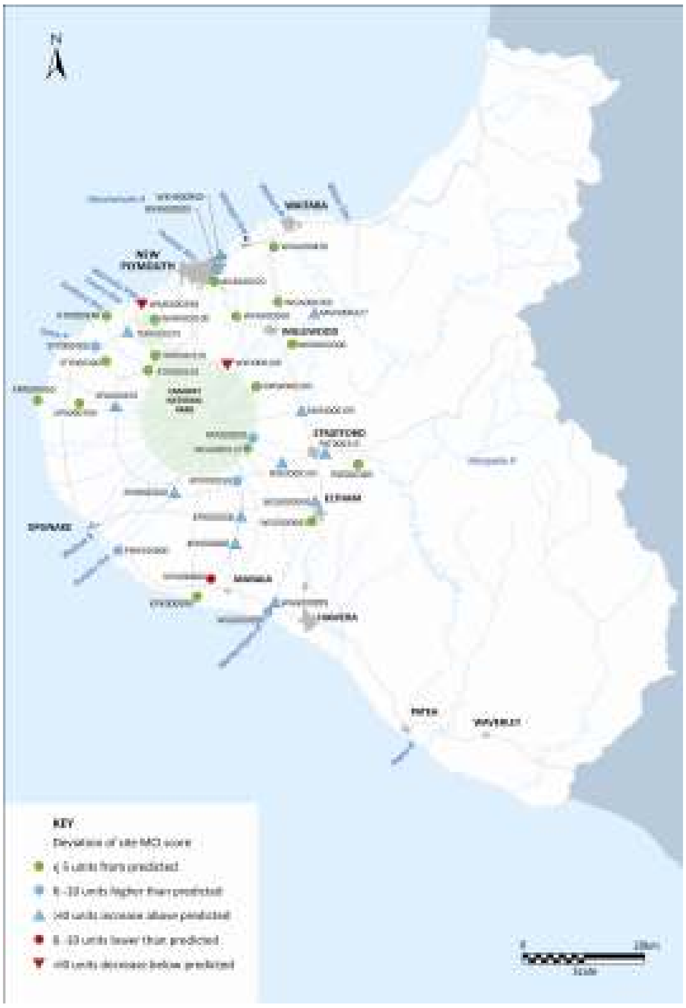


Figure 118 Spring 2009 MCI scores in relation to predicted downstream distance scores

In summary, 70% sites showed no significant detectable difference (Stark, 1998) between spring, 2009 scores and predicted distance (from the National Park) scores, while 26% of sites had significantly higher spring, 2009 MCI scores and 4% of sites had significantly lower spring, 2009 scores.

4.1.2 Summer surveys

4.1.2.1 Historical SEM

The majority of sites' (50 of 57 sites) faunal communities' MCI scores were similar to historical SEM medians for the particular sites (Figure 119). Significantly higher scores were found at five sites, while only two sites showed significantly lower MCI scores following summer, low flow conditions in the region.

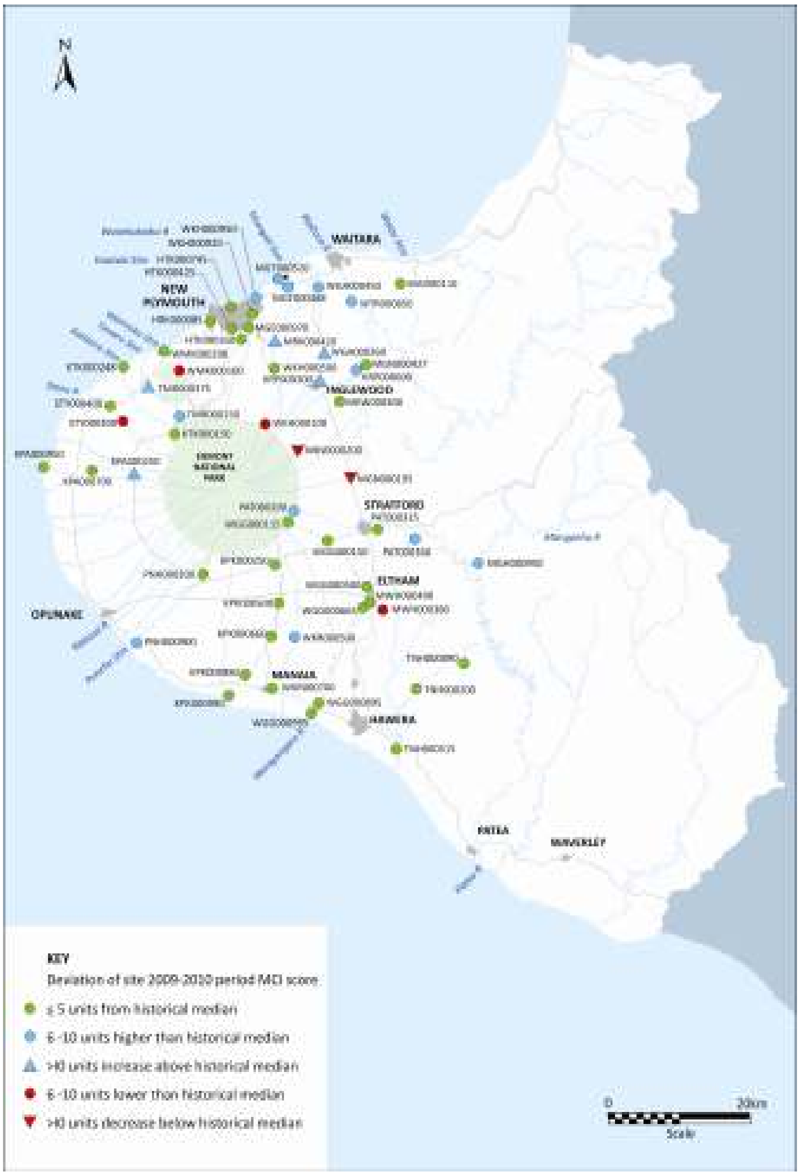


Figure 119 Summer 2010 MCI scores in relation to SEM historical median values

Significantly higher scores were found in the upper reaches of the Kapoaiaia Stream; mid reaches of the Timaru, Waiongana and Kurapete Streams; and in the lower reaches of the Mangaoraka Stream. Significantly lower scores were found in the upper reaches of the Maketawa Stream and in the mid reaches of the Manganui River.

Sites in the upper to mid reaches of several catchments (e.g., Stony, Waiwhakaiho, Manganui, and Maketawa) continued to show some impacts of earlier headwater erosion events.

In summary, 88% of sites showed no significant detectable differences (Stark, 1998) between summer, 2010 MCI scores and historical median scores, while 9% of sites had significantly higher summer, 2010 scores.

Fewer sites had significantly higher MCI scores (than historical medians) in summer than spring whereas slightly more summer than spring sites' scores were significantly lower than historical medians. However, in summer, 11% of sites were 6 or more MCI units lower than historical medians compared to 14% in spring whereas 30% of summer sites' scores were greater than 5 MCI units higher than historical medians compared to 42% in spring.

4.1.2.2 Predictive TRC ringplain altitude/distance models

Summer scores for each ringplain site have been assessed against predicted scores (Stark and Fowles, 2009) for altitude (Figure 120) and for distance from the National Park boundary for those ringplain sites with sources inside the National Park (Figure 120).

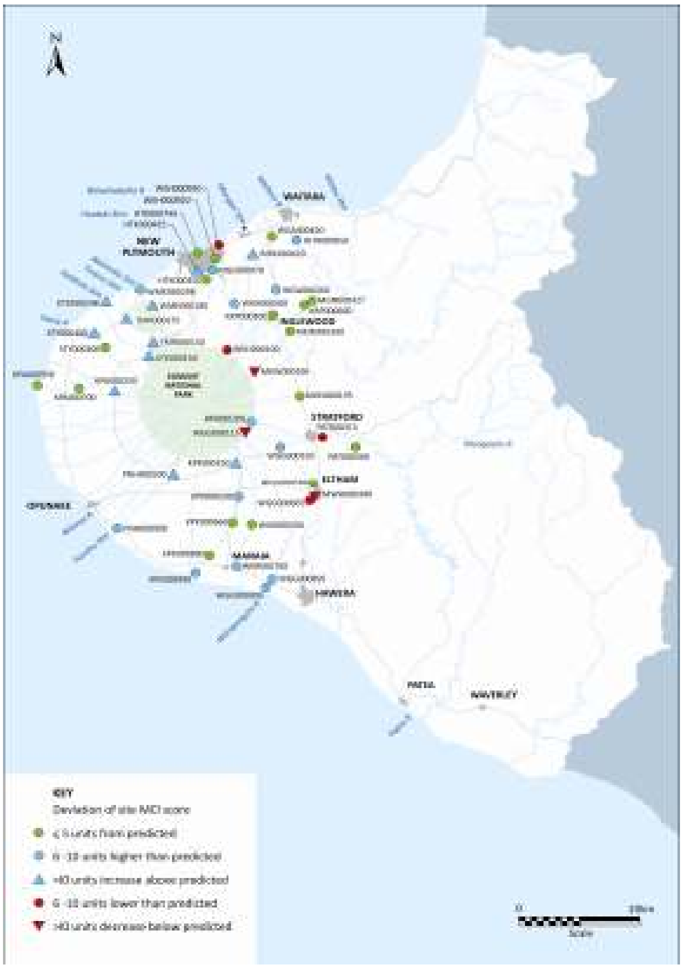


Figure 120 Summer 2010 MCI scores in relation to predicted altitude scores

4.1.2.2.1 Altitude

Only three sites had summer MCI scores greater than 5 units below predicted values, one of which (Mangawhero Stream near the Waingongoro River confluence) was downstream of a poorly assimilated Eltham municipal wastewater point source discharge. Seventeen sites had scores very similar to (within 5 units) predicted scores (Figure 120), while twenty-four sites' scores were more than 5 MCI units above predicted scores for sites at equivalent altitudes. Eleven sites had significantly higher MCI scores and these were situated in the upper reaches of the Waimoku, Timaru, Katikara, Kapoaiaia, Punehu, and Kaupokonui Streams; mid reaches of the Huatoki Stream (in the Domain); and in the lower reaches of the Stony River and Mangaoraka, Katikara, and Timaru Streams.

In summary, 71% of sites showed no significant detectable difference (Stark, 1998) between summer, 2010 scores and predicted altitude scores, while 23% of sites had significantly higher summer MCI scores and 6% of sites had significantly lower summer MCI scores.

4.1.2.2.2 Distance from National Park

Eight sites (five more than in spring) had summer MCI score more than 5 units below predicted values (Figure 121) but only two of these sites' scores (in the lower reaches of the Waimoku Stream and upper reaches of the Maketawa Stream) were significantly lower than predicted. Twelve sites had summer scores within 5 units of predicted scores, while eighteen sites' scores (the same number as in spring) were more than 5 units higher than predicted. There were six sites with scores significantly higher than predicted, six sites fewer than in spring. These sites were situated in the upper reaches of the Patea River and Kaupokunui Stream and mid reaches of the Waingongoro River, and Kapoaiaia, Kaupokonui and Timaru Streams (Figure 121).

In summary, 79% of sites showed no significant detectable difference (Stark, 1998) between summer, 2010 MCI scores and predicted distance (from National Park) scores, while 16% of sites had significantly higher summer scores and 5% of sites had significantly lower summer scores.

Comments
The general seasonal trend in MCI scores is summarised in Table 120 which provides the percentages of sites' scores in relation to predicted scores for spring and summer surveys.

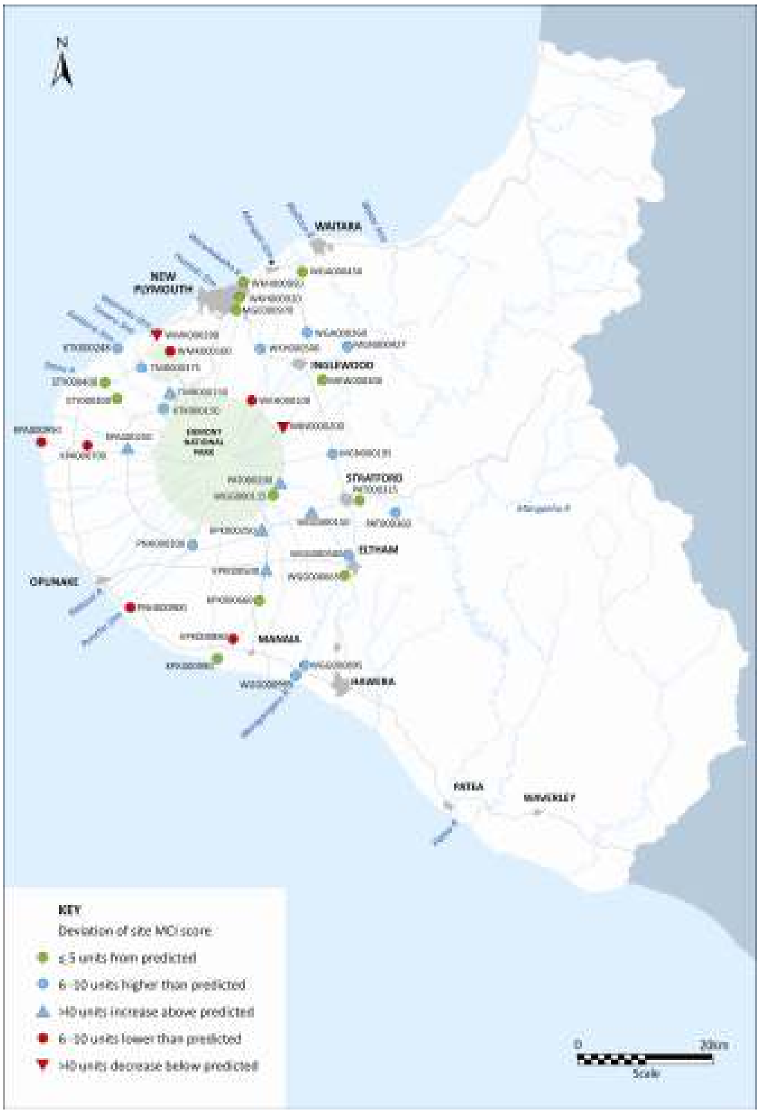


Figure 121 Summer 2010 MCI scores in relation to predicted downstream distance scores

Table 120 Percentages of spring and summer MCI scores for ringplain sites in relation to Stark and Fowles (2009) predicted (altitude and distance from National Park) scores

Season	Spring			Summer		
Prediction	> 10 units lower	± 10 units	> 10 units higher	> 10 units lower	± 10 units	> 10 units higher
Altitude	8	62	30	6	71	23
Distance	4	70	26	5	79	16

In general, while there was minimal difference between seasons in sites' percentages of scores falling significantly below predicted scores, there was a decrease of 7 to 10% of sites' scores significantly exceeding predicted scores during the summer survey, the latter of which has been typical of seasonal trends reported for most SEM annual surveys to date.

4.1.2.2.3 General Comments

Sites in the lower reaches of shorter ringplain streams (e.g. Punehu, Kapoaiaia and, in particular the Waimoku Stream), had median MCI scores showing the greatest disparity between predicted scores for altitude and distance from the National Park than might be anticipated from such models (see Appendix II). The actual MCI scores recorded at these sites had wider ranges between the predicted altitude score and the predicted distance score (e.g. 31 units for the Waimoku Stream at the coast, 12 units for the Punehu Stream at SH45, and 10 units for the Kapoaiaia Stream at Cape Egmont).

Consideration must therefore be given to the most appropriate predictive score which should be applied to a site in each case, assessed against length of catchment and site location, as the models developed by Stark and Fowles, 2009 utilised the historical macroinvertebrate 'control' sites database for the entire ringplain.

4.1.3 SEM MCI in relation to predictive scores

In addition to the relationships established for MCI scores and ringplain streams sites' altitude and distance from the National Park by Stark and Fowles (2009), 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 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. MCI scores from the fifteen year duration (1995 to 2010) of the SEM programme to date have been summarised in Appendix II and the median scores for all sites used to assess any deviations from those scores predicted by each of the three variables where relationships have been established (i.e. ringplain altitude and distance from the National Park, and REC (national)). Those sites' median MCI scores which deviated significantly (> 10 MCI units) from predicted scores are summarised in Table 121 and listed individually in Appendix II.

Table 121 Median SEM scores showing significant differences (> 10 MCI units) from predicted scores

Sites	Deviation from predicted scores					
	Altitude[1]		Distance[1]		REC[2]	
	Lower	Higher	Lower	Higher	Lower	Higher
Upper reaches	0%	4%	0%	5%	0%	0%
Mid reaches	4%	4%	3%	5%	12%	0%
Lower reaches	2%	5%	8%	0%	18%	0%
Total	6%	13%	11%	10%	30%	0%

[Notes: Stark and Fowles, 2009[1]; Leathwick[2]]

In summary, 19% of sites median MCI scores differed significantly from the predictions based upon altitude on the ringplain with the majority of these higher than predicted. 21% of sites' median scores differed significantly from predictions based on distance from the National Park boundary with very similar proportions higher and lower than predicted. No individual site's median MCI score differed significantly from both predicted altitude and distance scores (Appendix II). There were no significantly lower median scores in either category situated in the upper reaches of rivers and streams on the ringplain.

No median MCI scores significantly exceeded predicted scores based upon the REC system, whereas 30% of sites' scores were significantly lower, increasing in a downstream direction from none in the upper reaches through to 18% of sites in the lower reaches. Interestingly, very few sites' median scores exceeded the REC predictions in any reaches (five sites in total and only by a few MCI units). It should be noted that SEM median MCI scores effectively incorporate equal proportions of spring (higher) and summer (lower) scores and that the maximum scores for each site (over the 1995 to 2009 period) (invariably recorded in spring) have exceeded the REC predicted scores. Those sites where maximum scores have been 5 or more units below REC predictions are situated in the lower reaches of the Mangati Stream, mid reaches of the Patea River, lower reaches of the Mangaehu River, and mid reaches of the Mangawhero Stream. The proportion of sites (35%) where the maximum SEM MCI scores over the fifteen years to date has significantly (11 units or more) exceeded the REC predicted scores includes 16% of sites located in the lower reaches of catchments.

It should be noted that the REC model predicts scores which would be expected for the best possible conditions for those locations, while Stark and Fowles' (2009) altitude and distance relationships were based on observed conditions at "control" sites.

Ranking sites, on the basis of median SEM MCI scores for the fifteen 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). Table 122 provides the rankings on this basis of the six best and poorest sites in the SEM programme.

Table 122 Ranking of sites' median MCI scores (1995-2010) based on deviation from predictive scores

	Distance from National Park	REC
BEST	Manganui R. SH3 (m)	Huatoki S @ Domain (m)
	Waingongoro R @ Opunake Rd (m)	Patea R @ Barclay Rd (u)
	Patea R @ Barclay Rd (u)	Katikara S @ Carrington Rd (u)
	Kaupokonui S @ Opunake Rd (u)	Katikara S @ coast (l)
POOREST	Waimoku S @ coast (l)	Mangaehu Rd @ Raupuha Rd (l)
	Punehu S @ SH 45	Mangati S @ Bell Block (l)
	Kapoaiaia S @ coast (l)	Kaupokonui S @ u/s Lactose (m)
	Kapoaiaia S @ Wataroa Rd (m)	Mangawhero S @ Eltham (m)
		Mangawhero S @ d/s of Mangawharawhara S. (l)
		Timaru S @ SH 45 (l)

[Note: u = upper; m = middle; l = lower reaches]

The majority of the best ranked sites are located in the upper reaches and mid reaches of catchments with only one site in the lower reach of a stream. The Huatoki Stream in the Domain at New Plymouth has an extensive riparian cover provided by the Domain, but is excluded from the distance ranking as this stream is sourced outside of the National Park.

The majority of the poorest ranked streams are located in the lower reaches of catchments with the Kapoaiaia Stream (with very limited riparian cover) notable for its poor ranking at two sites and the two small streams (Mangati and Mangawhero), which receive significant point source discharges ranking poorly in terms of the REC predictions. (Note: these streams are excluded from the distance predictive rankings as these small catchments are located well away from the National Park).

4.1.4 Stream 'health' categorisation

A gradation of biological water quality conditions based upon ranges of MCI scores (see Page 3) has been used to determine the 'health' generically (Table 1) and predictively (Table 2) of each site by utilising the median score from the fifteen year period (1995-2010). These assessments are summarised in Appendix II and illustrated in Figure 122. The 'health' of streams in relation to the location of sites (upper, middle and lower reaches) in catchments is summarised in Table 123.

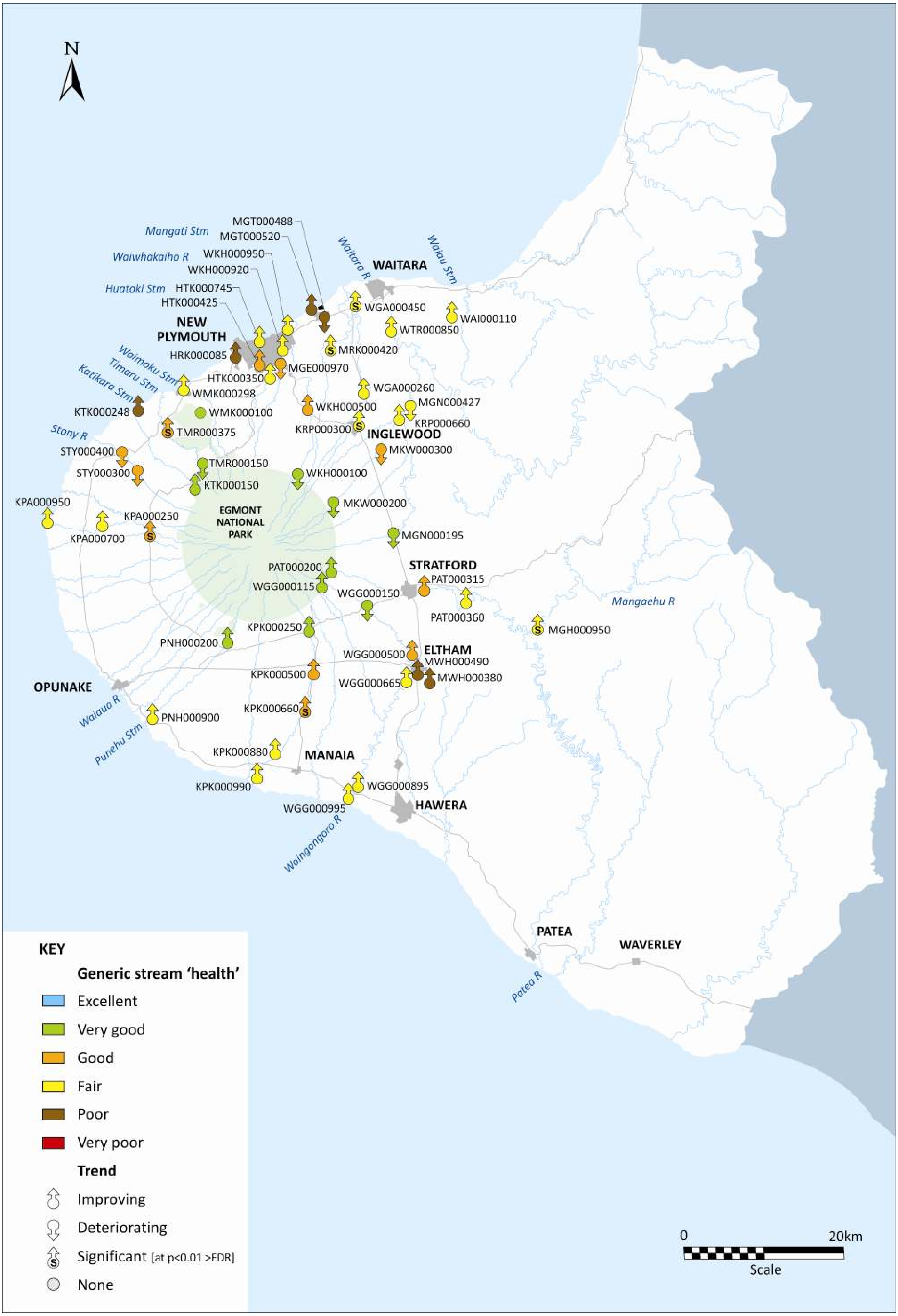


Figure 122 Generic biological 'health' (based on median MCI) and trends in biological quality for SEM sites, 1995 to 2010

Table 123 Stream 'health' assessments according to ringplain catchment reach (in terms of median MCI score)

'Health' grading	Reaches		
	Upper	Middle	Lower
Generic (Table 1) Excellent	0	0	0
Very good	7	4	0
Good	0	9	4
Fair	0	7	16
Poor	0	0	1
Very poor	0	0	0
Predictive (Table 2) Well above expected	0	4	1
Better than expected	4	6	9
Expected	2	10	10
Worse than expected	1	0	1
Well below expected	0	0	0
Median ranges (MCI units)	121-138 (17)	88-126 (38)	77-105 (28)

Typically generic 'health' (in terms of median MCI scores) decreases in a downstream direction from 'very good' in the upper reaches of catchments, through 'good-fair' in the middle reaches, to mainly 'fair' in the lower reaches toward the coast (Figure 123). In terms of predictive 'health', gradings have decreased from mainly 'better than expected' in the upper reaches through 'expected' in the middle and lower reaches. Very few sites exceeded 'better than expected' 'health' nor fell below 'expected' amongst the 48 sites assessed. Each site's 'health' may vary between seasons, usually by no more than one category (grading) either side of this median grading in response to preceeding stream flow and associated habitat (physical and physicochemical water quality) conditions. Generally there has been more seasonal variability in scores at sites in the mid reaches of catchments.

4.2 Macroinvertebrate fauna MCI trends

Temporal trends measured over the monitoring period between 1995 and 2010 (Table 124, Figure 123, and Appendix II) indicated that 40 sites showed improving MCI scores during the period, 12 sites deteriorating scores, and five sites could not be trended due to the short duration of monitoring at these sites.

Table 124 Summary of Mann-Kendall test results for MCI (stream 'health') scores trended over time (1995-2010) for 53 Taranaki streams/rivers (p without FDR applied)

Site code	N	p-level	+/-(ve)	Significance
STY000300	33	0.069	-ve	N/S
STY000400	33	0.247	-ve	N/S
TMR000150	30	0.495	-ve	N/S
TMR000375	30	<0.0001	+ve	signif*
MRK000420	30	<0.0001	+ve	signif*
WGA000260	31	0.268	+ve	N/S
WGA000450	30	<0.0001	+ve	signif*
WKH000100	16	0.650	-ve	N/S
WKH000500	33	0.007	+ve	signif*
WKH000920	31	0.327	+ve	N/S
WKH000950	29	0.307	+ve	N/S
MGE000970	16	0.586	-ve	N/S
MGN000195	32	0.081	-ve	N/S
MGN000427	30	0.828	-ve	N/S
MKW000200	21	0.096	-ve	N/S
MKW000300	20	0.578	-ve	N/S
WTR000850	30	0.023	+ve	signif
MGT000488	31	0.508	-ve	N/S
MGT000520	31	0.002	+ve	signif
WMK000100	22	1.000	+ve	N/S
WMK000298	22	0.066	+ve	N/S
WAI000110	23	0.108	+ve	N/S
PNH000200	30	0.101	+ve	N/S
PNH000900	30	0.007	+ve	signif
PAT000200	30	0.508	+ve	N/S
PAT000315	30	0.501	+ve	N/S
PAT000360	30	0.619	+ve	N/S
MGH000950	30	<0.0001	+ve	signif*
WGG000115	31	0.024	+ve	signif*
WGG000150	31	0.902	-ve	N/S
WGG000500	33	0.007	+ve	signif
WGG000665	30	0.276	+ve	N/S
WGG000895	31	0.211	+ve	N/S
WGG000995	30	0.065	+ve	N/S
MWH000380	30	0.092	+ve	N/S
MWH000490	30	0.178	+ve	N/S
HTK000350	28	0.002	+ve	signif
HTK000425	28	0.016	+ve	signif
HTK000745	28	0.612	+ve	N/S
KPK000250	23	0.913	+ve	N/S
KPK000500	26	0.002	+ve	signif
KPK000660	30	<0.0001	+ve	signif*
KPK000880	30	0.205	+ve	N/S
KPK000990	22	0.120	+ve	N/S
KTK000150	22	0.709	-ve	N/S
KTK000248	21	0.009	+ve	signif
KPA000250	22	<0.0001	+ve	signif
KPA000700	22	0.047	+ve	signif
KPA000950	22	0.509	+ve	N/S
KRP000300	31	<0.0001	+ve	signif*
KRP000660	31	0.003	+ve	signif
HRK000085	30	0.941	+ve	N/S
WKR000500	-	-	-	-
WKR000700	-	-	-	-
TNH000090	-	-	-	-
TNH000200	-	-	-	-
TNH000515	-	-	-	-

[N/S = not statistically significant (ie p≥0.05); * = significant after FDR applied; -ve = negative trend, +ve = positive trend]

However, the majority of these trends were not statistically significant for the monitoring period. The following is a summary of significant trends for the SEM period to date:

– seven sites with a positive very significant trend ($p \leq 0.01$ after FDR)
– eleven sites with a positive trend ($p < 0.05$) but not significant ($p > 0.01$) after FDR
– no sites with significant negative trends

The sites have also been ranked in order of the significance of the strongest trends in Table 125.

Table 125 Ranking of sites in terms of significant temporal trends in MCI scores over the period 1995-2010 [significant trend at $p<0.05$ and $p<0.01$]

Site	Valid N	p-level	p-value (FDR corrected)	Ecological significance (LOWESS-smoothed range)
KRP000300	31	<0.0001	0.0001	moderate, 17 units
KPK000660	30	<0.0001	0.0001	high, 32 units
TMR000375	30	<0.0001	0.0001	high, 24 units
MRK000420	30	<0.0001	0.0001	high, 20 units
MGH000950	30	<0.0001	0.0003	moderate, 16 units
WGA000450	30	0.0002	0.001	moderate, 18 units
KPA000250	22	0.0009	0.006	high, 34 units
HTK000350	28	0.0018	0.011	moderate, 13 units
MGT000520	31	0.0020	0.011	high, 21 units
KPK000500	26	0.0023	0.012	high, 20 units
KRP000660	31	0.0030	0.014	high, 20 units
WGG000500	33	0.0069	0.028	low, 8 units
PNH000900	30	0.0070	0.028	moderate, 18 units
KTK000248	21	0.0090	0.034	high, 20 units
HTK000425	28	0.0158	0.055	low, 9 units
WGG000115	31	0.0208	0.068	low, 10 units
WTR000850	30	0.0228	0.070	high, 23 units
KPA000700	22	0.0467	0.135	high, 22 units

Each of these site's trends is discussed more fully earlier in the report. In general, all but three of these sites exhibited MCI score variabilities over the SEM monitoring period which were ecologically significant, with nine sites showing variability of high ecological significance. Those sites with the strongest positive temporal improvement over the 15 year monitoring period, coupled with very significant ecological variability, have been:

– Kaupokonui Stream upstream of Fonterra, Kapuni factory
– Timaru Stream at SH45
– Mangaoraka Stream at Corbett Road
– Kapoaiaia Stream at Wiremu Road.

All four of these sites have illustrated particularly strong improvments over the most recent four year period.

Slightly lower positive temporal improvements, but very significant ecological variability have been shown at the following sites:

– Mangati Stream at Bell Block
– Kaupokonui Stream upstream of Kaponga WWTP
– Kurapete Stream 6 km downstream of Inglewood WWTP
– Katikara Stream at the coast.

5. Summary

These fifteenth spring and summer biomonitoring components of the established SEM programme were performed during the period from early November 2009 to late December 2009 (partially delayed by a wet early spring period), and February to mid March 2010. This report describes the macroinvertebrate fauna and microflora communities at 57 sites established through the Taranaki region (TRC, 1995b) including the more recently established riparian monitoring sites in the Katikara and Kapoaiaia Streams and additional 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). 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, 1999 (updated, 2009) and TRC 2006c) where applicable and also in relation to 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 fifteen 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 significance has been high.

6. Recommendations from the 2008-2009 report

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2009-2010 monitoring year by means of a similar programme to that undertaken in 2008-2009.

2. THAT temporal trending of the macroinvertebrate faunal data be updated on an annual basis.

The programme followed Recommendation 1 in the 2009-2010 monitoring year (with no additional sites required) and the temporal trend reporting was undertaken and included in the Annual Report.

7. Recommendations for 2010-2011

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2010-2011 monitoring year by means of a similar programme to that undertaken in 2009-2010.
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 tables

Table 126 Macroinvertebrate fauna of the Stony River: spring SEM survey sampled on 16 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		STY000300	STY000400
	Sample Number		FWB09346	FWB09347
CRUSTACEA	Isopoda	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	VA	A
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	R	R
COLEOPTERA (BEETLES)	Elmidae	6	R	-
	Staphylinidae	5	R	-
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	C	R
	Hydrobiosis	5	C	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	R
	Eriopterini	5	R	-
	Maoridiamesa	3	R	VA
	Orthocladiinae	2	A	VA
	Empididae	3	R	-
		No of taxa	11	6
		MCI	104	110
		SQMCIs	6.8	3.0
		EPT (taxa)	4	3
		%EPT (taxa)	36	50
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 127 Macroinvertebrate fauna of the Stony River: summer SEM survey sampled on 8 February 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		STY000300	STY000400
	Sample Number		FWB10097	FWB10098
CRUSTACEA	Isopoda	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	VA	VA
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	C	C
HEMIPTERA (BUGS)	*Saldula*	5	R	-
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	R
	Costachorema	7	A	C
	Hydrobiosis	5	C	C
DIPTERA (TRUE FLIES)	Eriopterini	5	R	-
	Maoridiamesa	3	R	C
	Orthocladiinae	2	A	C
		No of taxa	9	8
		MCI	104	105
		SQMCIs	6.9	7.4
		EPT (taxa)	5	5
		%EPT (taxa)	56	63
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 128 Macroinvertebrate fauna of the Timaru Stream: spring SEM survey sampled on 16 November 2009

Taxa List		MCI score	1	2
	Site Number		1	2
	Site Code		TMR000150	TMR000375
	Sample Number		FWB10099	FWB10100
ANNELIDA (WORMS)	Oligochaeta	1	-	R
MOLLUSCA	*Potamopyrgus*	4	-	R
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-
	Austroclima	7	R	C
	Coloburiscus	7	A	VA
	Deleatidium	8	VA	C
	Nesameletus	9	A	R
	Rallidens	9	-	C
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	R
	Megaleptoperla	9	R	-
	Stenoperla	10	R	R
	Zelandobius	5	R	R
	Zelandobius illiesi	10	R	-
	Zelandoperla	8	A	A
COLEOPTERA (BEETLES)	Elmidae	6	R	VA
	Hydraenidae	8	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	XA
	Costachorema	7	C	A
	Hydrobiosis	5	A	A
	Hydrobiosella	9	C	-
	Neurochorema	6	-	A
	Orthopsyche	9	R	-
	Polyplectropus	6	-	R
	Psilochorema	6	R	-
	Olinga	9	-	R
	Pycnocentrodes	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	VA
	Eriopterini	5	R	C
	Maoridiamesa	3	-	A
	Orthocladiinae	2	C	VA
	Polypedilum	3	C	-
	Tanypodinae	5	-	R
	Tanytarsini	3	-	C
	Empididae	3	-	R
	Muscidae	3	-	R
	Austrosimulium	3	-	C
	Tanyderidae	4	-	R
		No of taxa	23	31
		MCI	143	114
		SQMCIs	7.5	4.7
		EPT (taxa)	16	16
		%EPT (taxa)	70	52
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 129 Macroinvertebrate fauna of the Timaru Stream: summer SEM survey sampled on 8 February 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		TMR000150	TMR000375
	Sample Number		FWB09348	FWB09349
ANNELIDA (WORMS)	Oligochaeta	1	R	-
MOLLUSCA	*Potamopyrgus*	4	-	R
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-
	Austroclima	7	-	A
	Coloburiscus	7	C	A
	Deleatidium	8	XA	A
	Nesameletus	9	A	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-
	Austroperla	9	R	-
	Megaleptoperla	9	C	-
	Stenoperla	10	R	-
	Zelandobius	5	C	C
	Zelandoperla	8	VA	C
COLEOPTERA (BEETLES)	Elmidae	6	-	A
	Hydraenidae	8	R	-
	Ptilodactylidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	A
	Costachorema	7	C	C
	Hydrobiosis	5	C	-
	Hydrobiosella	9	R	-
	Neurochorema	6	-	R
	Orthopsyche	9	R	-
	Beraeoptera	8	-	C
	Olinga	9	-	R
	Pycnocentrodes	5	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	VA
	Eriopterini	5	C	C
	Maoridiamesa	3	R	VA
	Orthocladiinae	2	R	VA
	Tanypodinae	5	R	-
	Austrosimulium	3	-	R
		No of taxa	22	21
		MCI	133	120
		SQMCIs	7.9	4.4
		EPT (taxa)	14	12
		%EPT (taxa)	64	57
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 130 Macroinvertebrate fauna of the Mangaoraka Stream: spring SEM survey sampled on 10 November 2009

Taxa List	Site Number	MCI score	1
	Site Code		MRK000420
	Sample Number		FWB09317
NEMERTEA	Nemertea	3	R
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Latia*	5	C
	Potamopyrgus	4	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA
	Coloburiscus	7	A
	Deleatidium	8	A
	Nesameletus	9	R
	Zephlebia group	7	A
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	VA
COLEOPTERA (BEETLES)	Elmidae	6	XA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA
	Costachorema	7	C
	Hydrobiosis	5	C
	Neurochorema	6	R
	Pycnocentria	7	C
	Pycnocentrodes	5	XA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C
	Maoridiamesa	3	A
	Orthocladiinae	2	C
	Austrosimulium	3	R
		No of taxa	22
		MCI	105
		SQMCIs	5.4
		EPT (taxa)	12
		%EPT (taxa)	55
'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 Mangaoraka Stream: summer SEM survey sampled on 1 February 2010

Taxa List	Site Number	MCI score	1
	Site Code		MRK000420
	Sample Number		FWB10049
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Gyraulus*	3	R
	Potamopyrgus	4	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA
	Coloburiscus	7	C
	Deleatidium	8	R
	Nesameletus	9	C
	Rallidens	9	R
	Zephlebia group	7	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C
COLEOPTERA (BEETLES)	Elmidae	6	XA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA
	Costachorema	7	C
	Hydrobiosis	5	A
	Neurochorema	6	C
	Pycnocentrodes	5	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A
	Hexatomini	5	R
	Maoridiamesa	3	C
	Orthocladiinae	2	A
	Tanytarsini	3	A
	Empididae	3	R
	Muscidae	3	C
	Austrosimulium	3	C
		No of taxa	25
		MCI	102
		SQMCIs	5.5
		EPT (taxa)	12
		%EPT (taxa)	48
'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 Waiongana Stream: spring SEM survey sampled on 13 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		WGA000260	WGA000450
	Sample Number		FWB09343	FWB09344
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	C	VA
MOLLUSCA	*Latia*	5	-	C
	Potamopyrgus	4	R	VA
CRUSTACEA	*Paracalliope*	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C
	Coloburiscus	7	C	R
	Deleatidium	8	XA	C
	Nesameletus	9	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-
	Zelandobius	5	R	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
	Hydraenidae	8	R	-
	Staphylinidae	5	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	VA
	Costachorema	7	A	R
	Hydrobiosis	5	C	C
	Neurochorema	6	-	C
	Pycnocentrodes	5	A	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	A
	Eriopterini	5	R	-
	Maoridiamesa	3	VA	A
	Orthocladiinae	2	XA	A
	Polypedilum	3	-	R
	Tanytarsini	3	C	C
	Empididae	3	-	R
	Muscidae	3	R	R
	Austrosimulium	3	R	-
	Tanyderidae	4	R	-
		No of taxa	24	23
		MCI	101	93
		SQMCIs	4.9	4.0
		EPT (taxa)	10	9
		%EPT (taxa)	42	39
'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 Waiongana Stream: summer SEM survey sampled on 11 March 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		WGA000260	WGA000450
	Sample Number		FWB10152	FWB10153
NEMERTEA	Nemertea	3	-	C
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	R	VA
	Lumbricidae	5	R	-
MOLLUSCA	*Latia*	5	-	A
	Potamopyrgus	4	R	XA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	A
	Coloburiscus	7	C	R
	Deleatidium	8	VA	-
	Nesameletus	9	C	-
	Zephlebia group	7	R	-
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	XA
	Costachorema	7	R	-
	Hydrobiosis	5	A	A
	Neurochorema	6	C	C
	Beraeoptera	8	R	-
	Confluens	5	C	-
	Pycnocentrodes	5	A	-
	Triplectides	5	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	R
	Eriopterini	5	R	-
	Maoridiamesa	3	C	-
	Orthocladiinae	2	VA	A
	Tanytarsini	3	VA	VA
	Empididae	3	-	R
	Austrosimulium	3	A	-
		No of taxa	26	15
		MCI	106	91
		SQMCIs	4.7	3.9
		EPT (taxa)	14	5
		%EPT (taxa)	54	33
'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 Waiwhakaiho River: spring SEM survey sampled on 17 November 2009

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		WKH000100	WKH000500	WKH000920	WKH000950
	Sample Number		FWB09359	FWB09360	FWB09361	FWB09363
NEMATODA	Nematoda	3	-	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	-	R	A	XA
	Lumbricidae	5	-	-	R	-
MOLLUSCA	*Potamopyrgus*	4	-	-	-	R
CRUSTACEA	*Paratya*	3	-	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	-	-	R
	Coloburiscus	7	-	C	C	R
	Deleatidium	8	VA	XA	VA	A
	Nesameletus	9	-	R	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	-	R	C	C
	Megaleptoperla	9	R	-	-	-
	Zelandobius	5	-	R	-	R
	Zelandoperla	8	C	C	R	-
COLEOPTERA (BEETLES)	Elmidae	6	C	C	C	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R	R	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	R	A	A
	Costachorema	7	R	C	C	R
	Hydrobiosis	5	C	C	C	C
	Neurochorema	6	-	R	-	-
	Plectrocnemia	8	R	-	-	-
	Psilochorema	6	R	-	-	-
	Beraeoptera	8	-	R	-	-
	Oxyethira	2	-	-	-	R
	Pycnocentrodes	5	-	C	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	VA	C	C
	Eriopterini	5	-	C	-	-
	Maoridiamesa	3	R	A	VA	A
	Orthocladiinae	2	R	VA	A	VA
	Tanytarsini	3	-	R	C	C
	Empididae	3	R	R	R	R
	Ephydridae	4	-	R	-	R
	Muscidae	3	-	R	R	-
	Austrosimulium	3	-	-	-	R
	Tanyderidae	4	-	-	R	-
		No of taxa	12	23	19	22
		MCI	115	103	94	88
		SQMCIs	7.6	6.6	4.8	1.7
		EPT (taxa)	8	12	7	8
		%EPT (taxa)	67	52	37	36
'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 Waiwhakaiho River: summer SEM survey sampled on 10 March 2010

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		WKH000100	WKH000500	WKH000920	WKH000950
	Sample Number		FWB10140	FWB10141	FWB10142	FWB10144
NEMATODA	Nematoda	3	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R	C
MOLLUSCA	*Potamopyrgus*	4	-	-	-	C
CRUSTACEA	*Paratya*	3	-	-	R	-
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	-	-	-	R
	Coloburiscus	7	-	C	R	-
	Deleatidium	8	XA	XA	A	A
	Nesameletus	9	R	C	R	-
PLECOPTERA (STONEFLIES)	*Stenoperla*	10	R	-	-	-
	Zelandobius	5	R	-	-	-
	Zelandoperla	8	XA	C	R	R
HEMIPTERA (BUGS)	*Saldula*	5	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	A	A	A
	Hydraenidae	8	-	-	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	VA	VA	VA
	Costachorema	7	A	C	R	-
	Hydrobiosis	5	C	R	A	C
	Hydrobiosella	9	R	-	-	-
	Neurochorema	6	-	-	-	R
	Plectrocnemia	8	-	R	-	-
	Psilochorema	6	C	R	-	-
	Olinga	9	R	-	-	-
	Oxyethira	2	R	-	R	R
	Pycnocentrodes	5	-	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A	R	R
	Eriopterini	5	R	C	R	-
	Maoridiamesa	3	R	A	A	R
	Orthocladiinae	2	R	VA	A	VA
	Tanytarsini	3	-	C	A	A
	Muscidae	3	-	-	R	-
	Austrosimulium	3	-	R	R	R
	Tanyderidae	4	-	-	R	-
		No of taxa	18	18	20	18
		MCI	120	112	95	97
		SQMCIs	7.7	6.4	4.4	3.7
		EPT (taxa)	11	10	7	6
		%EPT (taxa)	61	56	35	33
'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 Mangorei Stream: spring SEM survey sampled on 17 November 2009

Taxa List	Site Number	MCI score	1
	Site Code		MGE000970
	Sample Number		FWB09358
NEMATODA	Nematoda	3	R
ANNELIDA (WORMS)	Oligochaeta	1	A
	Lumbricidae	5	R
MOLLUSCA	*Latia*	5	R
	Potamopyrgus	4	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A
	Coloburiscus	7	C
	Deleatidium	8	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R
	Zelandobius	5	C
	Zelandoperla	8	R
COLEOPTERA (BEETLES)	Elmidae	6	A
	Hydraenidae	8	R
	Ptilodactylidae	8	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA
	Costachorema	7	C
	Hydrobiosis	5	A
	Neurochorema	6	C
	Beraeoptera	8	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA
	Eriopterini	5	R
	Hexatomini	5	R
	Maoridiamesa	3	A
	Orthocladiinae	2	A
	Tanytarsini	3	C
	Empididae	3	C
	Muscidae	3	R
	Austrosimulium	3	C
	Tanyderidae	4	R
		No of taxa	30
		MCI	102
		SQMCIs	4.7
		EPT (taxa)	11
		%EPT (taxa)	37
'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 Mangorei Stream: summer SEM survey sampled on 10 March 2010

Taxa List	Site Number	MCI score	1
	Site Code		MGE000970
	Sample Number		FWB10139
ANNELIDA (WORMS)	Oligochaeta	1	C
MOLLUSCA	*Potamopyrgus*	4	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C
	Coloburiscus	7	C
	Deleatidium	8	R
	Nesameletus	9	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R
	Zelandoperla	8	C
COLEOPTERA (BEETLES)	Elmidae	6	A
	Ptilodactylidae	8	R
	Staphylinidae	5	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	XA
	Costachorema	7	C
	Hydrobiosis	5	C
	Neurochorema	6	R
	Oxyethira	2	R
	Triplectides	5	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R
	Orthocladiinae	2	VA
	Tanytarsini	3	A
	Empididae	3	C
	Muscidae	3	R
	Austrosimulium	3	VA
	Tanyderidae	4	R
		No of taxa	25
		MCI	102
		SQMCIs	3.8
		EPT (taxa)	11
		%EPT (taxa)	44
'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 Manganui River: spring SEM survey sampled on 13 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		MGN000195	MGN000427
	Sample Number		FWB09339	FWB09340
NEMATODA	Nematoda	3	-	R
CRUSTACEA	*Paracalliope*	5	C	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	-
	Coloburiscus	7	A	R
	Deleatidium	8	VA	XA
	Nesameletus	9	C	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-
	Megaleptoperla	9	R	-
	Zelandoperla	8	VA	-
COLEOPTERA (BEETLES)	Elmidae	6	A	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	R
	Costachorema	7	C	C
	Hydrobiosis	5	C	C
	Orthopsyche	9	C	-
	Psilochorema	6	R	-
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	VA
	Eriopterini	5	C	-
	Maoridiamesa	3	-	VA
	Orthocladiinae	2	C	XA
	Tanytarsini	3	-	C
	Muscidae	3	-	R
		No of taxa	17	15
		MCI	129	103
		SQMCIs	7.5	4.9
		EPT (taxa)	11	7
		%EPT (taxa)	65	47
'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 Manganui River: summer SEM survey sampled on 9 February 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		MGN000195	MGN000427
	Sample Number		FWB10107	FWB10108
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	R	C
MOLLUSCA	*Potamopyrgus*	4	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	-
	Coloburiscus	7	R	R
	Deleatidium	8	XA	VA
	Nesameletus	9	VA	C
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-
	Megaleptoperla	9	R	-
	Zelandoperla	8	C	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	VA
	Costachorema	7	R	A
	Hydrobiosis	5	A	A
	Psilochorema	6	C	-
	Olinga	9	R	-
	Pycnocentrodes	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	C	R
	Maoridiamesa	3	R	A
	Orthocladiinae	2	C	VA
	Polypedilum	3	C	-
	Tanypodinae	5	C	R
	Tanytarsini	3	-	A
	Empididae	3	-	R
	Muscidae	3	-	C
	Austrosimulium	3	R	R
		No of taxa	23	21
		MCI	115	97
		SQMCIs	7.6	4.9
		EPT (taxa)	12	8
		%EPT (taxa)	52	38
'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 Maketawa Stream: SEM spring survey sampled on 13 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		MKW000200	MKW000300
	Sample Number		FWB09341	FWB09342
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	R	A
	Deleatidium	8	VA	XA
	Nesameletus	9	C	C
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	A	R
COLEOPTERA (BEETLES)	Elmidae	6	C	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	C
	Costachorema	7	C	C
	Hydrobiosis	5	-	R
	Psilochorema	6	R	R
	Pycnocentrodes	5	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	A
	Eriopterini	5	C	C
	Maoridiamesa	3	C	C
	Orthocladiinae	2	C	A
	Tanytarsini	3	-	C
	Empididae	3	-	R
	Ephydridae	4	-	R
	Muscidae	3	-	R
		No of taxa	11	18
		MCI	120	106
		SQMCIs	7.4	7.5
		EPT (taxa)	7	8
		%EPT (taxa)	64	44
'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 Maketawa Stream: summer SEM survey sampled on 9 February 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		MKW000200	MKW000300
	Sample Number		FWB10109	FWB10110
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R
	Coloburiscus	7	R	C
	Deleatidium	8	XA	VA
	Nesameletus	9	C	R
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	R	-
	Zelandoperla	8	A	R
COLEOPTERA (BEETLES)	Elmidae	6	A	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	A
	Costachorema	7	A	A
	Hydrobiosis	5	C	C
	Psilochorema	6	C	R
	Oxyethira	2	R	-
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	C	C
	Maoridiamesa	3	C	A
	Orthocladiinae	2	C	A
	Polypedilum	3	C	-
	Tanypodinae	5	R	-
	Tanytarsini	3	-	C
	Empididae	3	-	R
	Muscidae	3	R	R
	Austrosimulium	3	-	R
	Tanyderidae	4	-	R
		No of taxa	19	21
		MCI	109	105
		SQMCIs	7.7	6.0
		EPT (taxa)	9	10
		%EPT (taxa)	47	48
'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 Waitara River: spring SEM survey sampled on 13 November 2009

Taxa List		MCI score	
	Site Number		**1**
	Site Code		**WTR000850**
	Sample Number		**FWB09345**
NEMATODA	Nematoda	3	R
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Potamopyrgus*	4	R
CRUSTACEA	*Paratya*	3	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R
	Coloburiscus	7	C
	Deleatidium	8	A
COLEOPTERA (BEETLES)	Elmidae	6	R
	Hydrophilidae	5	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A
	Costachorema	7	R
	Hydrobiosis	5	C
	Pycnocentrodes	5	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A
	Maoridiamesa	3	A
	Orthocladiinae	2	VA
	Tanytarsini	3	C
	Empididae	3	R
	Tanyderidae	4	R
		No of taxa	20
		MCI	92
		SQMCIs	3.4
		EPT (taxa)	7
		%EPT (taxa)	35
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa	

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 143 Waitara River: summer SEM survey sampled on 11 March 2010

Taxa List	Site Number	MCI score	1
	Site Code		WTR000850
	Sample Number		FWB10151
NEMERTEA	Nemertea	3	C
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Potamopyrgus*	4	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R
	Deleatidium	8	R
	Zephlebia group	7	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R
COLEOPTERA (BEETLES)	Elmidae	6	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA
	Costachorema	7	R
	Hydrobiosis	5	C
	Neurochorema	6	R
	Pycnocentrodes	5	C
DIPTERA (TRUE FLIES)	*Chironomus*	1	R
	Harrisius	6	R
	Orthocladiinae	2	A
	Tanytarsini	3	VA
	Empididae	3	R
	Austrosimulium	3	R
		No of taxa	20
		MCI	93
		SQMCIs	3.6
		EPT (taxa)	9
		%EPT (taxa)	45
'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: spring SEM survey sampled on 22 December 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		MGT000488	MGT000520
	Sample Number		FWB09412	FWB09418
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	A	XA
	Lumbricidae	5	C	-
MOLLUSCA	*Potamopyrgus*	4	VA	XA
CRUSTACEA	Isopoda	5	R	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	-
	Neurochorema	6	R	-
	Triplectides	5	-	C
DIPTERA (TRUE FLIES)	Orthocladiinae	2	A	C
	Polypedilum	3	R	-
	Psychodidae	1	R	-
	Austrosimulium	3	R	C
	Tanyderidae	4	-	R
		No of taxa	11	7
		MCI	69	63
		SQMCIs	3.4	2.5
		EPT (taxa)	2	1
		%EPT (taxa)	18	14
'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 Mangati Stream: summer SEM survey sampled on 11 March 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		MGT000488	MGT000520
	Sample Number		FWB10154	FWB10160
NEMERTEA	Nemertea	3	C	-
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	A	XA
HIRUDINEA (LEECHES)	Hirudinea	3	C	-
MOLLUSCA	*Potamopyrgus*	4	VA	XA
	Sphaeriidae	3	R	-
CRUSTACEA	Ostracoda	1	-	C
	Isopoda	5	C	R
	Paracalliope	5	C	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	-
TRICHOPTERA (CADDISFLIES)	*Neurochorema*	6	R	R
	Psilochorema	6	R	-
	Triplectides	5	-	VA
DIPTERA (TRUE FLIES)	Eriopterini	5	R	-
	Hexatomini	5	R	-
	Orthocladiinae	2	C	A
	Polypedilum	3	R	R
	Austrosimulium	3	A	R
	Tanyderidae	4	-	R
ACARINA (MITES)	Acarina	5	C	-
		No of taxa	16	12
		MCI	83	70
		SQMCIs	3.6	2.7
		EPT (taxa)	3	2
		%EPT (taxa)	19	17
'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 Waimoku Stream: spring SEM survey sampled on 16 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		WMK000100	WMK000298
	Sample Number		FWB09350	FWB09351
NEMERTEA	Nemertea	3	-	R
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	A
	Lumbricidae	5	R	R
MOLLUSCA	*Potamopyrgus*	4	C	VA
CRUSTACEA	Talitridae	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-
	Austroclima	7	VA	R
	Coloburiscus	7	VA	C
	Deleatidium	8	A	C
	Ichthybotus	8	C	-
	Neozephlebia	7	R	-
	Nesameletus	9	R	-
	Zephlebia group	7	A	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	C
	Austroperla	9	A	-
	Stenoperla	10	R	-
	Zelandobius	5	R	-
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	R	R
	Ptilodactylidae	8	A	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	-
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	-	R
	Hydrobiosis	5	R	C
	Hydrobiosella	9	A	-
	Orthopsyche	9	VA	-
	Psilochorema	6	R	R
	Pycnocentria	7	R	-
	Triplectides	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C
	Eriopterini	5	R	-
	Orthocladiinae	2	A	A
	Polypedilum	3	A	C
	Empididae	3	R	-
	Psychodidae	1	-	R
	Austrosimulium	3	-	R
	Tanyderidae	4	-	R
		No of taxa	29	22
		MCI	130	95
		SQMCIs	7.3	3.8
		EPT (taxa)	18	9
		%EPT (taxa)	62	41
'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 Waimoku Stream: summer SEM survey sampled on 8 February 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		WMK000100	WMK000298
	Sample Number		FWB10101	FWB10102
ANNELIDA (WORMS)	Oligochaeta	1	R	A
MOLLUSCA	*Potamopyrgus*	4	R	A
CRUSTACEA	Isopoda	5	R	-
	Paracalliope	5	R	-
	Paranephrops	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	C	-
	Austroclima	7	A	-
	Coloburiscus	7	VA	R
	Deleatidium	8	A	R
	Ichthybotus	8	C	-
	Nesameletus	9	R	-
	Zephlebia group	7	VA	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-
	Stenoperla	10	C	-
	Zelandobius	5	C	-
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	C	R
	Hydraenidae	8	R	-
	Ptilodactylidae	8	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	-
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	R	R
	Hydrobiosis	5	-	C
	Hydrobiosella	9	C	-
	Orthopsyche	9	A	R
	Oxyethira	2	-	R
	Triplectides	5	R	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C
	Eriopterini	5	R	-
	Limonia	6	R	-
	Orthocladiinae	2	C	VA
	Polypedilum	3	A	A
	Nothodixa	4	R	-
	Empididae	3	R	C
	Austrosimulium	3	-	A
	Tanyderidae	4	-	R
ACARINA (MITES)	Acarina	5	R	-
		No of taxa	32	16
		MCI	125	93
		SQMCIs	6.9	2.6
		EPT (taxa)	15	6
		%EPT (taxa)	47	38
'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 Waiau Stream: spring SEM survey sampled on 10 November 2009

Taxa List	Site Number	MCI score	1
	Site Code		WAI000110
	Sample Number		FWB09318
ANNELIDA (WORMS)	Oligochaeta	1	C
MOLLUSCA	*Latia*	5	A
	Potamopyrgus	4	VA
CRUSTACEA	*Paracalliope*	5	R
	Paratya	3	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C
COLEOPTERA (BEETLES)	Elmidae	6	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A
	Hydrobiosis	5	C
	Psilochorema	6	R
	Hudsonema	6	R
	Oxyethira	2	R
	Pycnocentria	7	C
	Pycnocentrodes	5	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A
	Maoridiamesa	3	C
	Orthocladiinae	2	A
	Polypedilum	3	C
		No of taxa	20
		MCI	91
		SQMCIs	4.7
		EPT (taxa)	8
		%EPT (taxa)	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 Waiau Stream: summer SEM survey sampled on 1 February 2010

Taxa List	Site Number	MCI score	1
	Site Code		WAI000110
	Sample Number		FWB10048
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Latia*	5	C
	Potamopyrgus	4	XA
CRUSTACEA	Ostracoda	1	R
	Paracalliope	5	A
	Paratya	3	R
	Paranephrops	5	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA
	Coloburiscus	7	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R
COLEOPTERA (BEETLES)	Elmidae	6	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A
	Hydrobiosis	5	C
	Hudsonema	6	R
	Oxyethira	2	C
	Pycnocentria	7	R
	Pycnocentrodes	5	C
DIPTERA (TRUE FLIES)	*Maoridiamesa*	3	R
	Orthocladiinae	2	VA
	Polypedilum	3	R
	Muscidae	3	R
	Austrosimulium	3	R
ACARINA (MITES)	Acarina	5	R
		No of taxa	24
		MCI	87
		SQMCIs	4.3
		EPT (taxa)	8
		%EPT (taxa)	33
'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 12 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		PNH000200	PNH000900
	Sample Number		FWB09324	FWB09325
ANNELIDA (WORMS)	Oligochaeta	1	-	A
	Lumbricidae	5	R	R
MOLLUSCA	*Potamopyrgus*	4	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C
	Coloburiscus	7	VA	R
	Deleatidium	8	XA	XA
	Nesameletus	9	VA	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R
	Austroperla	9	R	-
	Megaleptoperla	9	C	-
	Zelandoperla	8	VA	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
	Hydraenidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	R
	Costachorema	7	A	C
	Hydrobiosis	5	C	C
	Psilochorema	6	C	-
	Beraeoptera	8	VA	-
	Helicopsyche	10	C	-
	Olinga	9	C	R
	Pycnocentrodes	5	VA	XA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	A	R
	Maoridiamesa	3	VA	A
	Orthocladiinae	2	C	A
	Polypedilum	3	R	-
	Tanytarsini	3	-	R
	Austrosimulium	3	-	C
		No of taxa	25	21
		MCI	128	105
		SQMCIs	7.1	6.2
		EPT (taxa)	16	10
		%EPT (taxa)	64	48
'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 4 February 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		PNH000200	PNH000900
	Sample Number		FWB10064	FWB10065
NEMERTEA	Nemertea	3	-	R
NEMATOMORPHA	Nematomorpha	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	R	A
	Lumbricidae	5	-	R
MOLLUSCA	*Potamopyrgus*	4	R	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R
	Coloburiscus	7	A	-
	Deleatidium	8	XA	XA
	Nesameletus	9	VA	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-
	Megaleptoperla	9	C	-
	Stenoperla	10	R	-
	Zelandoperla	8	A	-
COLEOPTERA (BEETLES)	Elmidae	6	XA	XA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	A
	Costachorema	7	C	C
	Hydrobiosis	5	C	C
	Psilochorema	6	C	-
	Beraeoptera	8	VA	-
	Olinga	9	C	-
	Pycnocentrodes	5	XA	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C
	Eriopterini	5	A	-
	Maoridiamesa	3	C	A
	Orthocladiinae	2	R	A
	Tanytarsini	3	-	C
	Empididae	3	-	C
	Austrosimulium	3	-	C
	Tanyderidae	4	-	R
		No of taxa	23	21
		MCI	125	92
		SQMCIs	6.6	6.3
		EPT (taxa)	15	7
		%EPT (taxa)	65	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 Patea River: spring SEM survey sampled on 6 November 2009

Taxa List	Site Number	MCI score	1	2	3
	Site Code		PAT000200	PAT000315	PAT000360
	Sample Number		FWB09304	FWB09305	FWB09310
NEMATODA	Nematoda	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	-	C
MOLLUSCA	*Potamopyrgus*	4	-	-	C
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-	-
	Austroclima	7	R	R	-
	Coloburiscus	7	VA	XA	A
	Deleatidium	8	XA	XA	XA
	Nesameletus	9	R	A	-
	Zephlebia group	7	-	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	C	R
	Austroperla	9	C	R	-
	Megaleptoperla	9	C	R	R
	Stenoperla	10	R	-	-
	Zelandobius	5	A	R	R
	Zelandoperla	8	VA	A	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	A
	Hydraenidae	8	C	C	-
	Hydrophilidae	5	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	C	A
	Costachorema	7	C	R	C
	Hydrobiosis	5	R	-	C
	Hydrobiosella	9	C	-	-
	Neurochorema	6	-	R	R
	Orthopsyche	9	A	-	-
	Psilochorema	6	R	-	-
	Beraeoptera	8	A	A	-
	Confluens	5	-	R	-
	Helicopsyche	10	C	-	-
	Olinga	9	C	-	-
	Pycnocentria	7	R	-	-
	Pycnocentrodes	5	-	A	C
	Triplectides	5	-	R	-
	Zelolessica	7	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	VA
	Eriopterini	5	-	R	R
	Limonia	6	R	-	-
	Maoridiamesa	3	-	C	VA
	Orthocladiinae	2	C	C	VA
	Polypedilum	3	R	-	-
	Tanypodinae	5	-	R	-
	Tanytarsini	3	-	R	R
	Ceratopogonidae	3	R	-	-
	Empididae	3	R	-	-
	Austrosimulium	3	-	R	R
		No of taxa	32	27	21
		MCI	135	119	98
		SQMCIs	7.7	7.3	6.2
		EPT (taxa)	22	17	10
		%EPT (taxa)	69	63	48
'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 Patea River: summer SEM survey sampled on 2 February 2010

Taxa List	Site Number	MCI score	1	2	3
	Site Code		PAT000200	PAT000315	PAT000360
	Sample Number		FWB10050	FWB10051	FWB10056
ANNELIDA (WORMS)	Oligochaeta	1	-	C	A
MOLLUSCA	*Potamopyrgus*	4	-	R	A
CRUSTACEA	*Paracalliope*	5	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	R	R
	Coloburiscus	7	VA	XA	A
	Deleatidium	8	XA	XA	VA
	Nesameletus	9	C	VA	R
	Zephlebia group	7	R	-	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-	-
	Megaleptoperla	9	C	-	-
	Stenoperla	10	C	-	-
	Taraperla	10	C	-	-
	Zelandobius	5	C	-	-
	Zelandoperla	8	C	C	R
COLEOPTERA (BEETLES)	Elmidae	6	A	VA	VA
	Hydraenidae	8	C	C	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	VA	XA
	Costachorema	7	C	C	A
	Hydrobiosis	5	C	C	A
	Hydrobiosella	9	A	-	-
	Neurochorema	6	-	R	-
	Orthopsyche	9	A	-	-
	Psilochorema	6	-	R	-
	Beraeoptera	8	R	-	-
	Helicopsyche	10	A	-	-
	Olinga	9	C	R	-
	Pycnocentria	7	R	-	-
	Pycnocentrodes	5	-	R	C
	Zelolessica	7	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	VA	A
	Eriopterini	5	-	R	R
	Hexatomini	5	R	-	-
	Maoridiamesa	3	-	R	VA
	Orthocladiinae	2	A	A	A
	Polypedilum	3	A	C	-
	Tanypodinae	5	-	C	-
	Tanytarsini	3	-	R	A
	Empididae	3	-	-	R
	Muscidae	3	-	-	C
	Austrosimulium	3	-	R	-
	Tanyderidae	4	-	R	-
		No of taxa	27	26	22
		MCI	145	108	105
		SQMCIs	7.6	6.9	4.6
		EPT (taxa)	20	12	9
		%EPT (taxa)	74	46	41
'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 Mangaehu River: spring SEM survey sampled on 6 November 2009

Taxa List	Site Number	MCI score	1
	Site Code		MGH000950
	Sample Number		FWB09313
MOLLUSCA	*Latia*	5	R
	Potamopyrgus	4	R
CRUSTACEA	*Paracalliope*	5	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C
	Mauiulus	5	R
	Zephlebia group	7	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	A
	Zelandobius	5	C
COLEOPTERA (BEETLES)	Elmidae	6	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C
	Costachorema	7	C
	Hydrobiosis	5	C
	Beraeoptera	8	R
	Pycnocentrodes	5	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA
	Maoridiamesa	3	VA
	Orthocladiinae	2	VA
	Tanytarsini	3	C
	Austrosimulium	3	C
		No of taxa	19
		MCI	99
		SQMCIs	3.9
		EPT (taxa)	10
		%EPT (taxa)	53
'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 Mangaehu River: summer SEM survey sampled on 2 February 2010

Taxa List	Site Number	MCI score	1
	Site Code		MGH000950
	Sample Number		FWB10059
ANNELIDA (WORMS)	Oligochaeta	1	C
MOLLUSCA	*Latia*	5	C
	Potamopyrgus	4	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A
	Deleatidium	8	R
	Zephlebia group	7	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R
COLEOPTERA (BEETLES)	Elmidae	6	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA
	Costachorema	7	R
	Hydrobiosis	5	A
	Pycnocentrodes	5	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA
	Maoridiamesa	3	VA
	Orthocladiinae	2	A
	Polypedilum	3	R
	Tanytarsini	3	C
	Muscidae	3	R
		No of taxa	19
		MCI	95
		SQMCIs	4.3
		EPT (taxa)	8
		%EPT (taxa)	42
'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 Waingongoro River: spring SEM survey sampled on 30 November 2009

Taxa List	Site Number	MCI score	1	2	3	4	5	6
	Site Code		WGG000115	WGG000150	WGG000500	WGG000665	WGG000895	WGG000995
	Sample Number		FWB09377	FWB09378	FWB09379	FWB09382	FWB09383	FWB09384
NEMATODA	Nematoda	3	-	-	R	-	-	-
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R	R	VA	VA
	Lumbricidae	5	-	-	-	R	A	R
MOLLUSCA	*Potamopyrgus*	4	-	-	R	R	A	A
	Sphaeriidae	3	-	-	-	-	-	R
CRUSTACEA	*Paracalliope*	5	-	-	-	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	C	R	-	R	C
	Coloburiscus	7	VA	XA	A	R	-	-
	Deleatidium	8	XA	XA	XA	XA	VA	C
	Nesameletus	9	C	A	R	-	-	-
	Zephlebia group	7	-	-	R	-	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	A	C	-	-	-	-
	Austroperla	9	R	R	-	-	-	-
	Megaleptoperla	9	A	C	-	-	-	-
	Spaniocerca	8	R	-	-	-	-	-
	Stenoperla	10	R	R	-	-	-	-
	Zelandobius	5	C	-	C	C	R	R
	Zelandoperla	8	VA	A	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	VA	VA	A	A
	Hydraenidae	8	R	C	R	-	-	-
	Hydrophilidae	5	R	-	-	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	A	R	C	-
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	A	XA	VA	XA	XA
	Costachorema	7	R	R	A	A	C	C
	Hydrobiosis	5	R	C	A	C	A	C
	Beraeoptera	8	A	VA	-	-	-	-
	Confluens	5	C	R	-	-	-	-
	Helicopsyche	10	A	A	-	-	-	-
	Olinga	9	C	A	-	-	-	-
	Pycnocentrodes	5	C	A	C	R	VA	VA
	Zelolessica	7	A	R	-	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	VA	C	A	R	C
	Eriopterini	5	R	C	C	-	-	-
	Chironomus	1	-	-	-	-	R	-
	Maoridiamesa	3	R	-	A	VA	R	XA
	Orthocladiinae	2	R	-	-	A	-	C
	Tanypodinae	5	-	-	R	-	-	-
	Tanytarsini	3	R	-	-	-	-	-
	Empididae	3	R	R	-	R	-	-
	Ephydridae	4	-	-	-	-	-	R
	Muscidae	3	R	-	-	R	-	-
	Austrosimulium	3	-	-	R	-	-	-
ACARINA (MITES)	Acarina	5	-	-	-	-	R	-
		No of taxa	31	24	22	17	16	17
		MCI	126	138	111	94	98	93
		SQMCIs	7.5	7.2	6.0	6.5	4.3	3.5
		EPT (taxa)	20	18	11	7	7	7
		%EPT (taxa)	65	75	50	41	44	41
'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: summer SEM survey sampled on 8 February 2010

Taxa List	Site Number	MCI score	1	2	3	4	5	6
	Site Code		WGG000115	WGG000150	WGG000500	WGG000665	WGG000895	WGG000995
	Sample Number		FWB10083	FWB10084	FWB10085	FWB10090	FWB10091	FWB10092
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	-	-	-	-	R
NEMERTEA	Nemertea	3	-	-	-	R	R	R
NEMATODA	Nematoda	3	-	-	R	-	R	-
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R	C	A	VA
	Lumbricidae	5	-	-	-	R	R	R
MOLLUSCA	*Latia*	5	-	-	-	-	-	R
	Potamopyrgus	4	R	-	R	R	VA	VA
CRUSTACEA	*Paracalliope*	5	-	-	-	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C	R	R	R	C
	Coloburiscus	7	A	VA	A	C	-	-
	Deleatidium	8	XA	XA	XA	A	A	-
	Mauiulus	5	-	-	-	-	-	R
	Nesameletus	9	C	A	C	-	-	-
	Zephlebia group	7	-	R	-	R	R	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-	-	-	-	-
	Austroperla	9	C	R	-	-	-	-
	Megaleptoperla	9	A	C	-	-	-	-
	Stenoperla	10	R	-	-	-	-	-
	Taraperla	10	C	-	-	-	-	-
	Zelandobius	5	-	R	-	-	-	-
	Zelandoperla	8	A	C	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	VA	VA	VA	A
	Hydraenidae	8	C	C	R	-	-	-
	Hydrophilidae	5	R	-	-	-	-	-
	Ptilodactylidae	8	-	R	-	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	A	R	C	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	C	VA	XA	XA	XA
	Costachorema	7	C	-	R	A	R	C
	Hydrobiosis	5	C	C	A	A	A	C
	Hydrobiosella	9	-	R	-	-	-	-
	Neurochorema	6	-	-	-	-	R	-
	Psilochorema	6	R	-	-	-	-	-
	Beraeoptera	8	R	C	-	-	-	-
	Confluens	5	R	R	-	-	-	-
	Helicopsyche	10	R	R	-	-	-	-
	Olinga	9	C	C	-	-	-	-
	Pycnocentria	7	R	-	-	-	-	-
	Pycnocentrodes	5	-	A	R	C	VA	VA
	Zelolessica	7	C	-	-	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	C	R	R	R
	Eriopterini	5	R	C	C	-	-	-
	Hexatomini	5	-	-	R	-	-	-
	Harrisius	6	-	-	-	-	R	-
	Maoridiamesa	3	C	-	R	XA	C	VA
	Orthocladiinae	2	A	C	C	VA	A	VA
	Polypedilum	3	C	C	-	R	R	-
	Tanytarsini	3	-	-	A	A	-	C
	Empididae	3	R	R	-	R	-	-
	Ephydridae	4	-	-	-	-	-	A
	Muscidae	3	R	-	-	-	-	-
	Austrosimulium	3	-	R	R	R	R	-
	Tanyderidae	4	-	-	-	R	-	-
		No of taxa	32	27	22	23	21	20
		MCI	128	129	105	93	95	91
		SQMCIs	7.6	7.5	6.9	3.7	4.4	3.6
		EPT (taxa)	20	17	9	8	8	7
		%EPT (taxa)	63	63	41	35	38	35
'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 Mangawhero Stream: spring SEM survey sampled on 30 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		MWH000380	MWH000490
	Sample Number		FWB09385	FWB09386
ANNELIDA (WORMS)	Oligochaeta	1	VA	VA
MOLLUSCA	*Physa*	3	-	R
	Potamopyrgus	4	R	A
CRUSTACEA	Ostracoda	1	-	A
	Paracalliope	5	VA	XA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	R
	Deleatidium	8	C	C
	Zephlebia group	7	R	-
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	-	C
COLEOPTERA (BEETLES)	Elmidae	6	R	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	VA
	Costachorema	7	-	R
	Hydrobiosis	5	C	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	R
	Chironomus	1	R	R
	Maoridiamesa	3	A	A
	Orthocladiinae	2	A	C
	Polypedilum	3	R	-
	Muscidae	3	-	R
	Austrosimulium	3	R	C
		No of taxa	15	18
		MCI	85	81
		SQMCIs	4.2	4.2
		EPT (taxa)	5	6
		%EPT (taxa)	33	33
'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 Mangawhero Stream: summer SEM survey sampled on 8 February 2010

Taxa List		MCI score	1	2
	Site Number		1	2
	Site Code		MWH000380	MWH000490
	Sample Number		FWB10093	FWB10096
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	C	XA
	Lumbricidae	5	-	R
MOLLUSCA	*Physa*	3	-	R
	Potamopyrgus	4	R	A
CRUSTACEA	Ostracoda	1	A	XA
	Paracalliope	5	XA	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	C
HEMIPTERA (BUGS)	*Saldula*	5	-	R
COLEOPTERA (BEETLES)	Elmidae	6	-	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	XA
	Hydrobiosis	5	C	A
	Oecetis	4	-	R
	Oxyethira	2	C	R
	Pycnocentrodes	5	-	R
	Triplectides	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	R
	Limonia	6	R	-
	Chironomus	1	R	-
	Maoridiamesa	3	R	A
	Orthocladiinae	2	A	A
	Polypedilum	3	C	C
	Muscidae	3	-	R
	Austrosimulium	3	R	C
		No of taxa	14	23
		MCI	67	79
		SQMCIs	5.0	2.3
		EPT (taxa)	3	6
		%EPT (taxa)	21	26
'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 Huatoki Stream: spring SEM survey sampled on 17 November 2009

Taxa List	Site Number	MCI score	1	2	3
	Site Code		HTK000350	HTK000425	HTK000745
	Sample Number		FWB09352	FWB09355	FWB09357
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R	-
NEMERTEA	Nemertea	3	-	-	R
NEMATODA	Nematoda	3	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	A	A	XA
	Lumbricidae	5	-	-	R
HIRUDINEA (LEECHES)	Hirudinea	3	-	-	R
MOLLUSCA	*Latia*	5	C	C	R
	Potamopyrgus	4	C	VA	VA
	Sphaeriidae	3	-	-	R
CRUSTACEA	Ostracoda	1	-	-	R
	Paracalliope	5	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A	-
	Coloburiscus	7	C	C	R
	Deleatidium	8	-	R	-
	Nesameletus	9	A	R	-
	Zephlebia group	7	C	A	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	A	VA	-
	Zelandoperla	8	C	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	VA	A
	Ptilodactylidae	8	R	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	A	R
	Costachorema	7	C	R	-
	Hydrobiosis	5	C	C	-
	Neurochorema	6	R	-	-
	Pycnocentrodes	5	A	A	R
	Triplectides	5	-	R	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	R	-
	Maoridiamesa	3	A	-	-
	Orthocladiinae	2	VA	C	R
	Polypedilum	3	R	C	R
	Tanytarsini	3	C	-	-
	Paradixa	4	R	-	-
	Empididae	3	-	R	-
	Muscidae	3	R	-	-
	Austrosimulium	3	R	A	-
	Tanyderidae	4	-	R	C
ACARINA (MITES)	Acarina	5	-	-	R
		No of taxa	26	25	20
		MCI	100	105	85
		SQMCIs	4.2	4.9	1.8
		EPT (taxa)	11	12	5
		%EPT (taxa)	42	48	25
'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 Huatoki Stream: summer SEM survey sampled on 12 March 2010

Taxa List	Site Number	MCI score	1	2	3
	Site Code		HTK000350	HTK000425	HTK000745
	Sample Number		FWB10162	FWB10165	FWB10167
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R	-	-
NEMERTEA	Nemertea	3	C	C	R
ANNELIDA (WORMS)	Oligochaeta	1	C	A	XA
MOLLUSCA	*Latia*	5	C	C	R
	Potamopyrgus	4	A	A	VA
	Sphaeriidae	3	-	-	R
CRUSTACEA	*Paratya*	3	-	R	-
	Paranephrops	5	-	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C	-
	Coloburiscus	7	VA	VA	R
	Deleatidium	8	-	R	R
	Nesameletus	9	VA	R	-
	Zephlebia group	7	VA	VA	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	-	R	-
	Zelandobius	5	R	C	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	VA
	Ptilodactylidae	8	R	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	VA	R
	Costachorema	7	R	-	-
	Hydrobiosis	5	A	C	-
	Neurochorema	6	R	-	-
	Confluens	5	-	R	-
	Pycnocentrodes	5	-	R	R
	Triplectides	5	-	R	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	R	R
	Maoridiamesa	3	C	-	-
	Orthocladiinae	2	A	C	A
	Polypedilum	3	-	R	-
	Tanytarsini	3	VA	-	R
	Empididae	3	-	-	R
	Muscidae	3	R	-	-
	Austrosimulium	3	C	VA	-
	Tanyderidae	4	-	R	R
		No of taxa	23	26	17
		MCI	98	104	88
		SQMCIs	5.7	5.2	2.2
		EPT (taxa)	9	12	5
		%EPT (taxa)	39	46	29
'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 Kaupokonui River: spring SEM survey sampled on 12 November 2009

Taxa List	Site Number	MCI score	1	2	3	4	5
	Site Code		KPK000250	KPK000500	KPK000990	KPK000660	KPK000880
	Sample Number		FWB09321	FWB09322	FWB09323	FWB09329	FWB09332
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	-	R	-	-
NEMATODA	Nematoda	3	-	R	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	-	-	A	-	VA
	Lumbricidae	5	-	-	C	R	R
MOLLUSCA	*Potamopyrgus*	4	R	-	VA	-	R
CRUSTACEA	*Paratya*	3	-	-	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	R	R	-	-
	Coloburiscus	7	A	XA	-	A	-
	Deleatidium	8	XA	XA	VA	XA	VA
	Nesameletus	9	C	A	-	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	C	-	A	R
	Megaleptoperla	9	A	R	-	R	-
	Stenoperla	10	R	R	-	R	-
	Zelandobius	5	R	R	R	-	R
	Zelandoperla	8	A	A	-	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	A	VA	VA
	Hydraenidae	8	R	R	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	R	C	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	A	A	R	VA
	Costachorema	7	C	C	A	C	R
	Hydrobiosis	5	-	R	A	-	A
	Psilochorema	6	R	R	-	-	-
	Beraeoptera	8	A	A	-	-	-
	Helicopsyche	10	C	R	-	-	-
	Olinga	9	A	C	-	R	-
	Pycnocentrodes	5	C	VA	VA	R	C
	Triplectides	5	R	-	-	-	-
	Zelolessica	7	R	-	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	VA	C	A	C
	Eriopterini	5	C	C	-	A	-
	Chironomus	1	-	-	-	-	R
	Maoridiamesa	3	A	VA	VA	A	VA
	Orthocladiinae	2	C	VA	VA	A	VA
	Polypedilum	3	R	-	-	-	-
	Tanypodinae	5	-	-	-	R	-
	Tanytarsini	3	-	R	R	R	R
		No of taxa	27	26	19	20	17
		MCI	127	126	91	122	89
		SQMCIs	7.6	6.5	4.4	7.1	4.1
		EPT (taxa)	18	17	7	11	7
		%EPT (taxa)	67	65	37	55	41

'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 Kaupokonui Stream: summer SEM survey sampled on 5 February 2010

Taxa List	Site Number	MCI score	1	2	3	4	5
	Site Code		KPK000250	KPK000500	KPK000990	KPK000660	KPK000880
	Sample Number		FWB10069	FWB10070	FWB10073	FWB10075	FWB10078
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	-	R	-	R
NEMERTEA	Nemertea	3	-	-	R	-	C
ANNELIDA (WORMS)	Oligochaeta	1	-	R	XA	C	XA
	Lumbricidae	5	-	-	R	R	R
MOLLUSCA	*Potamopyrgus*	4	-	R	VA	A	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R	C	R	C
	Coloburiscus	7	A	XA	R	C	R
	Deleatidium	8	VA	XA	R	VA	R
	Ichthybotus	8	R	-	-	-	-
	Nesameletus	9	C	VA	-	C	-
	Zephlebia group	7	R	-	R	-	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	R	-	-	-
	Megaleptoperla	9	A	-	-	R	-
	Stenoperla	10	C	-	-	-	-
	Zelandoperla	8	VA	C	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	R	VA	VA
	Hydraenidae	8	C	C	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	R	A	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	VA	VA	VA	VA
	Costachorema	7	R	R	C	C	-
	Hydrobiosis	5	R	C	A	A	A
	Hydrobiosella	9	R	-	-	-	-
	Neurochorema	6	-	R	-	-	-
	Plectrocnemia	8	-	R	-	-	-
	Psilochorema	6	R	-	-	-	-
	Beraeoptera	8	-	A	-	-	-
	Helicopsyche	10	R	-	-	-	-
	Olinga	9	A	A	-	R	-
	Oxyethira	2	-	-	R	-	R
	Pycnocentrodes	5	-	VA	VA	C	A
	Zelolessica	7	R	-	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	R	R	-
	Eriopterini	5	C	C	-	C	-
	Maoridiamesa	3	C	-	A	C	C
	Orthocladiinae	2	C	C	XA	A	XA
	Polypedilum	3	R	-	-	-	-
	Tanytarsini	3	-	-	-	R	C
	Empididae	3	-	-	-	R	-
	Muscidae	3	R	-	C	-	-
	Austrosimulium	3	-	R	-	R	-
	Tabanidae	3	-	-	-	C	-
	Tanyderidae	4	-	R	-	-	-
ACARINA (MITES)	Acarina	5	-	R	-	-	-
		No of taxa	27	25	20	23	17
		MCI	134	120	94	104	88
		SQMCIs	7.1	7.0	2.3	5.6	2.4
		EPT (taxa)	18	14	8	10	6
		%EPT (taxa)	67	56	40	43	35
'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 Katikara Stream: spring SEM survey sampled on 12 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		KTK000150	KTK000248
	Sample Number		FWB09326	FWB09327
ANNELIDA (WORMS)	Oligochaeta	1	-	A
MOLLUSCA	*Latia*	5	-	R
	Potamopyrgus	4	-	XA
CRUSTACEA	*Paratya*	3	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	A
	Coloburiscus	7	R	C
	Deleatidium	8	A	A
	Nesameletus	9	A	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	R
	Austroperla	9	C	-
	Spaniocerca	8	R	-
	Stenoperla	10	R	-
	Zelandobius	5	C	R
	Zelandoperla	8	VA	-
COLEOPTERA (BEETLES)	Elmidae	6	-	VA
	Ptilodactylidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	VA
	Costachorema	7	C	C
	Hydrobiosis	5	R	C
	Hydrobiosella	9	R	-
	Beraeoptera	8	-	R
	Pycnocentrodes	5	-	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	A
	Eriopterini	5	R	-
	Maoridiamesa	3	R	A
	Orthocladiinae	2	C	A
	Polypedilum	3	-	R
	Tanytarsini	3	R	C
	Empididae	3	-	R
	Austrosimulium	3	-	C
	Tanyderidae	4	-	R
		No of taxa	17	25
		MCI	129	97
		SQMCIs	7.7	4.4
		EPT (taxa)	12	10
		%EPT (taxa)	71	40
'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 Katikara Stream: summer SEM survey sampled on 3 February 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		KTK000150	KTK000248
	Sample Number		FWB10060	FWB10061
ANNELIDA (WORMS)	Oligochaeta	1	-	A
MOLLUSCA	*Latia*	5	-	R
	Potamopyrgus	4	-	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	A
	Coloburiscus	7	R	C
	Deleatidium	8	C	VA
	Nesameletus	9	C	R
	Rallidens	9	-	C
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	R
	Spaniocerca	8	R	-
	Zelandobius	5	-	R
	Zelandobius illiesi	10	R	-
	Zelandoperla	8	A	-
COLEOPTERA (BEETLES)	Elmidae	6	R	XA
	Hydraenidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	XA
	Costachorema	7	C	C
	Hydrobiosis	5	A	A
	Hydrobiosella	9	R	-
	Neurochorema	6	R	-
	Beraeoptera	8	-	R
	Pycnocentrodes	5	-	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A
	Eriopterini	5	R	-
	Maoridiamesa	3	-	A
	Orthocladiinae	2	A	A
	Polypedilum	3	-	C
	Tanytarsini	3	-	A
	Empididae	3	-	R
	Muscidae	3	-	R
	Austrosimulium	3	-	R
		No of taxa	15	26
		MCI	139	107
		SQMCIs	5.8	5.1
		EPT (taxa)	11	12
		%EPT (taxa)	73	46
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 166 Macroinvertebrate fauna of the Kapoaiaia Stream: spring SEM survey sampled on 4 November 2009

Taxa List	Site Number	MCI score	1	2	3
	Site Code		KPA000250	KPA000700	KPA000950
	Sample Number		FWB09301	FWB09302	FWB09303
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R	-
NEMERTEA	Nemertea	3	-	R	-
NEMATODA	Nematoda	3	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	R	C	C
	Lumbricidae	5	-	R	-
MOLLUSCA	*Potamopyrgus*	4	-	R	VA
CRUSTACEA	Ostracoda	1	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	R	-
	Coloburiscus	7	VA	R	-
	Deleatidium	8	XA	A	R
	Nesameletus	9	A	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	A	-
	Austroperla	9	-	R	-
	Megaleptoperla	9	R	-	-
	Stenoperla	10	R	-	-
	Zelandobius	5	R	R	R
	Zelandoperla	8	A	R	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	A
	Hydraenidae	8	-	R	-
	Ptilodactylidae	8	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	A	VA
	Costachorema	7	C	C	-
	Hydrobiosis	5	R	C	C
	Beraeoptera	8	R	-	-
	Olinga	9	R	-	-
	Pycnocentria	7	R	-	-
	Pycnocentrodes	5	C	R	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	C
	Eriopterini	5	C	C	-
	Limonia	6	-	R	-
	Maoridiamesa	3	A	VA	XA
	Orthocladiinae	2	A	VA	C
	Tanytarsini	3	-	R	R
	Empididae	3	-	R	-
	Austrosimulium	3	-	R	-
	Tanyderidae	4	-	R	-
		No of taxa	23	30	15
		MCI	123	101	83
		SQMCIs	7.2	4.3	3.4
		EPT (taxa)	16	11	5
		%EPT (taxa)	70	37	33
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 167 Macroinvertebrate fauna of the Kapoaiaia Stream: summer SEM survey sampled on 4 February 2010

Taxa List	Site Number	MCI score	1	2	3
	Site Code		KPA000250	KPA000700	KPA000950
	Sample Number		FWB10066	FWB10067	FWB10068
ANNELIDA (WORMS)	Oligochaeta	1	-	R	A
MOLLUSCA	*Potamopyrgus*	4	R	R	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	-	C
	Coloburiscus	7	VA	-	R
	Deleatidium	8	XA	VA	-
	Nesameletus	9	A	-	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-	-
	Stenoperla	10	R	R	-
	Zelandoperla	8	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	XA	VA
	Hydraenidae	8	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	VA	VA
	Costachorema	7	C	C	-
	Hydrobiosis	5	C	A	C
	Olinga	9	C	-	-
	Pycnocentrodes	5	-	C	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	C
	Eriopterini	5	C	R	-
	Maoridiamesa	3	C	A	A
	Orthocladiinae	2	C	VA	VA
	Tanytarsini	3	-	C	R
	Empididae	3	-	C	R
	Muscidae	3	-	C	R
		No of taxa	19	17	15
		MCI	129	95	87
		SQMCIs	7.1	5.4	3.9
		EPT (taxa)	11	6	5
		%EPT (taxa)	58	35	33
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 168 Macroinvertebrate fauna of the Kurapete Stream: spring SEM survey sampled on 10 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		KRP000300	KRP000660
	Sample Number		FWB09319	FWB09320
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	C	A
	Lumbricidae	5	-	R
MOLLUSCA	*Ferrissia*	3	R	-
	Potamopyrgus	4	VA	A
CRUSTACEA	Paraleptamphopidae	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	A
	Coloburiscus	7	R	C
	Deleatidium	8	R	C
	Zephlebia group	7	XA	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	R
	Zelandobius	5	R	A
	Zelandoperla	8	-	R
ODONATA (DRAGONFLIES)	*Antipodochlora*	5	-	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
	Ptilodactylidae	8	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	VA
	Costachorema	7	R	C
	Hydrobiosis	5	A	C
	Oxyethira	2	-	R
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A
	Eriopterini	5	R	-
	Maoridiamesa	3	R	A
	Orthocladiinae	2	A	A
	Tanypodinae	5	R	-
	Tanytarsini	3	-	R
	Empididae	3	-	R
	Austrosimulium	3	A	R
	Tanyderidae	4	R	-
		No of taxa	24	25
		MCI	99	100
		SQMCIs	6.2	4.5
		EPT (taxa)	9	11
		%EPT (taxa)	38	44
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 169 Macroinvertebrate fauna of the Kurapete Stream: summer SEM survey sampled on 1 February 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		KRP000300	KRP000660
	Sample Number		FWB10046	FWB10047
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R	-
NEMERTEA	Nemertea	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	A	VA
	Lumbricidae	5	R	-
MOLLUSCA	*Ferrissia*	3	C	-
	Potamopyrgus	4	VA	A
CRUSTACEA	Isopoda	5	R	-
	Paraleptamphopidae	5	-	R
	Talitridae	5	R	-
	Paranephrops	5	R	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C
	Coloburiscus	7	R	C
	Deleatidium	8	C	C
	Nesameletus	9	R	C
	Zephlebia group	7	XA	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	-	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
	Ptilodactylidae	8	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	VA
	Costachorema	7	-	C
	Hydrobiosis	5	C	A
	Neurochorema	6	R	-
	Polyplectropus	6	R	-
	Oxyethira	2	-	C
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	C
	Eriopterini	5	R	-
	Maoridiamesa	3	-	R
	Orthocladiinae	2	-	VA
	Polypedilum	3	R	-
	Tanypodinae	5	R	-
	Tanytarsini	3	-	R
	Muscidae	3	-	C
	Austrosimulium	3	C	R
	Tanyderidae	4	C	R
		No of taxa	26	25
		MCI	103	100
		SQMCIs	6.0	3.9
		EPT (taxa)	9	10
		%EPT (taxa)	35	40
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 170 Macroinvertebrate fauna of the Waiokura Stream: spring SEM survey sampled on 12 November 2009

Taxa List	Site Number	MCI score	1	2
	Site Code		WKR000500	WKR000700
	Sample Number		FWB09333	FWB09334
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	A	A
MOLLUSCA	*Potamopyrgus*	4	C	A
CRUSTACEA	*Paracalliope*	5	R	R
	Paraleptamphopidae	5	R	-
	Paranephrops	5	R	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	XA
	Coloburiscus	7	C	C
	Deleatidium	8	C	R
	Zephlebia group	7	A	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C	C
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	A
	Costachorema	7	C	-
	Ecnomidae/Psychomyiidae	6	-	C
	Hydrobiosis	5	R	R
	Psilochorema	6	-	C
	Hudsonema	6	-	R
	Pycnocentria	7	-	R
	Pycnocentrodes	5	C	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	R
	Maoridiamesa	3	C	R
	Orthocladiinae	2	A	R
	Tanytarsini	3	C	-
	Muscidae	3	R	-
	Tanyderidae	4	-	R
		No of taxa	21	22
		MCI	99	103
		SQMCIs	5.3	6.5
		EPT (taxa)	9	11
		%EPT (taxa)	43	50
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 171 Macroinvertebrate fauna of the Waiokura Stream: summer SEM survey sampled on 5 February 2010

Taxa List	Site Number	MCI score	1	2
	Site Code		WKR000500	WKR000700
	Sample Number		FWB10079	FWB10081
NEMERTEA	Nemertea	3	R	-
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	C	A
MOLLUSCA	*Potamopyrgus*	4	A	C
CRUSTACEA	*Paracalliope*	5	C	-
	Paraleptamphopidae	5	C	C
	Paranephrops	5	R	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	VA
	Coloburiscus	7	-	VA
	Deleatidium	8	A	R
	Zephlebia group	7	C	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C	-
COLEOPTERA (BEETLES)	Elmidae	6	XA	VA
	Staphylinidae	5	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	XA	XA
	Costachorema	7	R	-
	Hydrobiosis	5	C	A
	Psilochorema	6	R	R
	Pycnocentria	7	R	-
	Pycnocentrodes	5	A	-
	Zelolessica	7	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	-
	Eriopterini	5	R	-
	Maoridiamesa	3	C	-
	Orthocladiinae	2	-	R
	Austrosimulium	3	R	R
ACARINA (MITES)	Acarina	5	R	-
		No of taxa	25	16
		MCI	104	100
		SQMCIs	5.2	5.2
		EPT (taxa)	11	7
		%EPT (taxa)	44	44
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 172 Macroinvertebrate fauna of the Tangahoe River: spring SEM survey sampled on 9 November 2009

Taxa List	Site Number	MCI score	1	2	3
	Site Code		TNH000090	TNH000200	TNH000515
	Sample Number		FWB09314	FWB09315	FWB09316
ANNELIDA (WORMS)	Oligochaeta	1	A	C	A
MOLLUSCA	*Latia*	5	-	R	A
	Potamopyrgus	4	XA	A	XA
CRUSTACEA	*Paracalliope*	5	-	-	R
	Paratya	3	R	-	-
	Paranephrops	5	-	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	VA	-
	Coloburiscus	7	-	R	R
	Deleatidium	8	-	VA	R
	Mauiulus	5	-	-	C
	Zephlebia group	7	A	VA	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	A	-
	Zelandobius	5	-	R	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	A	VA
	Hydraenidae	8	R	-	-
	Hydrophilidae	5	R	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	A	A
	Hydrobiosis	5	C	R	R
	Neurochorema	6	-	R	-
	Oxyethira	2	R	-	-
	Pycnocentrodes	5	-	A	VA
	Triplectides	5	R	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	C	-
	Hexatomini	5	R	-	-
	Harrisius	6	-	R	-
	Orthocladiinae	2	R	-	-
	Austrosimulium	3	C	R	-
	Tanyderidae	4	R	-	R
		No of taxa	18	20	17
		MCI	92	106	104
		SQMCIs	4.7	6.6	4.4
		EPT (taxa)	6	10	9
		%EPT (taxa)	33	50	53
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

R = Rare   C = Common   A = Abundant   VA = Very Abundant   XA = Extremely Abundant

Table 173 Macroinvertebrate fauna of the Tangahoe River: summer SEM survey sampled on 15 February 2010

Taxa List	Site Number	MCI score	1	2	3
	Site Code		TNH000090	TNH000200	TNH000515
	Sample Number		FWB10111	FWB10112	FWB10113
NEMERTEA	Nemertea	3	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	C	C	A
	Lumbricidae	5	R	-	-
MOLLUSCA	*Latia*	5	-	C	C
	Potamopyrgus	4	XA	C	A
CRUSTACEA	*Paracalliope*	5	-	-	R
	Paratya	3	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	VA	C
	Coloburiscus	7	-	A	R
	Deleatidium	8	A	VA	C
	Rallidens	9	R	C	-
	Zephlebia group	7	A	VA	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	-	R	-
	Zelandobius	5	-	C	R
	Zelandoperla	8	-	R	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	VA
	Hydraenidae	8	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	XA	XA
	Costachorema	7	-	R	R
	Hydrobiosis	5	R	A	C
	Neurochorema	6	R	C	-
	Oxyethira	2	R	R	R
	Pycnocentrodes	5	-	R	C
	Triplectides	5	C	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A	A
	Eriopterini	5	R	-	-
	Harrisius	6	R	C	-
	Maoridiamesa	3	-	R	A
	Orthocladiinae	2	R	C	A
	Polypedilum	3	R	-	C
	Tanypodinae	5	R	-	-
	Tanytarsini	3	-	A	R
	Paradixa	4	R	-	-
	Empididae	3	R	-	-
	Austrosimulium	3	A	-	R
	Tanyderidae	4	R	C	R
		No of taxa	24	27	26
		MCI	97	108	92
		SQMCIs	4.5	5.3	4.2
		EPT (taxa)	8	13	10
		%EPT (taxa)	33	48	38
'Tolerant' taxa	'Moderately sensitive' taxa		'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 174 Macroinvertebrate fauna of the Herekawe Stream: spring SEM survey sampled on 22 December 2009

Taxa List	Site Number	MCI score	1
	Site Code		HRK000085
	Sample Number		FWB09410
ANNELIDA (WORMS)	Oligochaeta	1	A
	Lumbricidae	5	R
MOLLUSCA	*Potamopyrgus*	4	VA
CRUSTACEA	*Paracalliope*	5	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R
	Coloburiscus	7	C
COLEOPTERA (BEETLES)	Elmidae	6	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C
	Hydrobiosis	5	R
	Oxyethira	2	R
	Triplectides	5	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R
	Harrisius	6	R
	Maoridiamesa	3	C
	Orthocladiinae	2	A
	Polypedilum	3	C
	Paradixa	4	R
	Empididae	3	R
	Austrosimulium	3	C
	Tanyderidae	4	R
		No of taxa	20
		MCI	84
		SQMCIs	4.0
		EPT (taxa)	5
		%EPT (taxa)	25
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa	

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 175 Macroinvertebrate fauna of the Herekawe Stream: summer SEM survey sampled on 12 March 2010

Taxa List	Site Number	MCI score	1
	Site Code		HRK000085
	Sample Number		FWB10168
NEMERTEA	Nemertea	3	R
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Potamopyrgus*	4	XA
CRUSTACEA	Isopoda	5	R
	Paracalliope	5	XA
	Paranephrops	5	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C
	Coloburiscus	7	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R
	Hydrobiosis	5	R
	Orthopsyche	9	R
	Oxyethira	2	A
	Triplectides	5	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R
	Orthocladiinae	2	C
	Polypedilum	3	R
	Paradixa	4	R
	Austrosimulium	3	A
	Tanyderidae	4	R
		No of taxa	20
		MCI	90
		SQMCIs	4.5
		EPT (taxa)	6
		%EPT (taxa)	30
'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, 2009-2010 and historical MCI scores, predicted scores and 1995-2010 trends

Summary of MCI scores at all SEM sites: significance in relation to various predictive methodologies (Stark and Fowles, 2009[1]; Leathwick, 2008[2]), and trends over the SEM period 1995 to 2010

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI Values									Trends (1995-2010)			Ecological significance
				SEM 1995 to 2010						Predicted						
				Spring 2009	Summer 2010	Range	Median	Median stream 'health' category: Generic[3]	Median stream 'health' category: Predicted by reach[4]	Altitude[1]	Distance[1]	REC[2]	p	p>FDR	+ / -	
STY000300	CX/H/VA/S/MO/MG	160	7.3	(104)	(104)	64-160	113	Good	Better than	101[+]	109[0]	128[-]	0.069	0.170	-ve	-
STY000400	CX/H/VA/S/MO/MG	70	12.5	(110)	(105)	0-160	108	Good	Well above	92[+]	103[0]	115[0]	0.247	0.401	-ve	-
TMR000150	CX/H/VA/IF/LO/HG	420	0	133	143	119-144	136	Very good	Better than	127[0]	132[0]	141[0]	0.495	0.662	-ve	-
TMR000375	CX/L/VA/P/MO/MG	100	10.9	120	114	89-120	101	Good	Expected	95[0]	105[0]	117[-]	<0.0001	0.000	+ve	Yes
MRK000420	WW/L/VA/P/MO/LG	60	N/A	105	102	75-104	89	Fair	Expected	91[0]	N/A	92[0]	<0.0001	0.000	+ve	Yes
WGA000260	CX/L/VA/P/MO/LG	140	16.1	101	106	82-112	95	Fair	Expected	99[0]	100[0]	99[0]	0.268	0.422	+ve	-
WGA000450	WW/L/VA/P/MO/LG	20	31.2	93	91	72-102	85	Fair	Expected	86[0]	93[0]	88[0]	<0.0002	0.001	+ve	Yes
WKH000100	CX/H/VA/IF/LO/HG	460	0	115	120	121-146	127	Very good	Worse than	131[0]	132[0]	137[0]	0.650	0.735	-ve	-
WKH000500	CX/H/VA/P/MO/MG	175	10.6	103	112	87-122	108	Good	Better than	102[0]	105[0]	115[0]	0.151	0.280	+ve	-
WKH000920	CX/H/VA/P/HO/LG	20	26.6	94	95	71-108	94	Fair	Better than	86[0]	95[0]	97[0]	0.327	0.473	+ve	-
WKH000950	CX/H/VA/P/HO/LG	2	28.4	88	97	70-111	88	Fair	Expected	85[0]	94[0]	97[0]	0.308	0.457	+ve	-
MGE000970	CX/L/VA/P/MO/LG	90	15.6	102	102	86-113	104	Good	Better than	94[0]	101(0)	101[0]	0.586	0.708	-ve	-
MGN000195	CX/H/VA/P/MO/LG	330	8.7	129	115	113-143	126	Very good	Well above	118[0]	107[+]	124[0]	0.081	0.192	-ve	-
MGN000427	CX/L/VA/P/HO/MG	140	37.9	103	97	77-115	98	Fair	Better than	99[0]	91[0]	103[0]	0.828	0.896	-ve	-
MKW000200	CX/H/VA/IF/MO/MG	380	2.3	120	109	100-141	127	Very good	Better than	123[0]	121[0]	130[0]	0.096	0.209	-ve	-
MKW000300	CX/H/VA/P/MO/LG	150	15.5	106	105	90-115	100	Good	Expected	100[0]	101[0]	111[-]	0.578	0.708	-ve	-
WTR000850	WX/L/SS/P/HO/LG	15	N/A	92	93	64-101	86	Fair	Expected	85[0]	N/A	98[-]	0.023	0.070	+ve	-
MGT000488	WN/L/VA/P/LO/LG	30	N/A	69	83	56-85	77	N/A	N/A[5]	N/A	N/A	80[0]	0.508	0.662	-ve	-
MGT000520	WW/L/VA/U/LO/LG	20	N/A	63	70	44-76	63	N/A	N/A[5]	N/A	N/A	88[-]	0.002	0.011	+ve	Yes
WMK000100	WW/L/VA/P/LO/HG	160	0	130	125	121-137	131	Very good	Expected	101[+]	132[0]	128[0]	1.000	1.000	0	-
WMK000298	WW/L/VA/P/MO/MG	1	4.0	95	93	75-101	89	Fair	Expected	85[0]	116[-]	103[-]	0.066	0.170	+ve	-
WAI000110	WW/L/VA/P/MO/LG	50	N/A	91	87	80-98	88	Fair	N/A	N/A	N/A	91[0]	0.108	0.216	+ve	-
PNH000200	CX/H/YA/IF/MO/MG	270	4.4	128	125	104-133	122	Very good	Well above	112[0]	115[0]	121[0]	0.101	0.209	+ve	-
PNH000900	CW/L/VA/P/MO/LG	20	20.9	105	92	70-99	85	Fair	Expected	86[0]	98[-]	100[-]	0.007	0.028	+ve	Yes
PAT000200	CX/H/VA/IF/MO/MG	500	1.9	135	145	127-143	137	Very good	Better than	135[0]	125[+]	129[0]	0.508	0.662	+ve	-
PAT000315	CX/H/VA/P/MO/LG	300	12.9	119	108	99-130	110	Good	Better than	115[0]	103[0]	112[0]	0.561	0.708	+ve	-
PAT000360	CW/L/VA/P/HO/LG	240	19.2	98	105	86-104	97	Fair	Expected	109[-]	99[0]	109[-]	0.619	0.716	+ve	-
MGH000950	CW/L/SS/P/HO/LG	120	N/A	99	95	77-104	88	Fair	N/A	N/A	N/A	117[-]	<0.0001	0.0003	+ve	Yes
WGG000115	CX/H/VA/IF/LO/MG	540	0.7	126	128	122-139	133	Very good	Expected	140[0]	130[0]	131[0]	0.021	0.068	+ve	No
WGG000150	CX/H/VA/P/LO/MG	380	7.2	138	129	119-139	129	Very good	Well above	123[0]	110[+]	124[0]	0.902	0.949	-ve	-
WGG000500	CW/L/VA/P/MO/LG	200	23.0	111	105	91-115	101	Good	Better than	105[0]	97[0]	110[0]	0.007	0.028	+ve	No
WGG000665	CW/L/VA/P/HO/MG	180	29.6	94	93	77-105	93	Fair	Expected	103[0]	94[0]	102[0]	0.276	0.422	+ve	-
WGG000895	CW/L/VA/P/HO/LG	40	63.0	98	95	73-105	95	Fair	Better than	89[0]	85[0]	92[0]	0.212	0.355	+ve	-
WGG000995	CW/L/VA/P/HO/MG	5	66.6	93	91	69-98	88	Fair	Expected	85[0]	85[0]	95[0]	0.065	0.170	+ve	-
MWH000380	WW/L/M/P/MO/LG	200	N/A	85	67	58-79	73	N/A	N/A[5]	N/A	N/A	92[-]	0.092	0.209	+ve	-
MWH000490	CN/L/VA/P/MO/LG	190	N/A	81	79	63-86	77	Poor	Worse than	104[-]	N/A	93[-]	0.178	0.319	+ve	-
HTK000350	WX/L/VA/P/MO/LG	60	N/A	100	98	79-105	94	Fair	Expected	91[0]	N/A	95[0]	0.002	0.011	+ve	Yes
HTK000425	WW/L/VA/P/MO/LG	30	N/A	105	104	91-115	102	Good	Better than	87[+]	N/A	92[0]	0.016	0.055	+ve	No
HTK000745	WW/L/VA/U/MO/MG	5	N/A	85	88	69-99	86	Fair	Expected	85[0]	N/A	93[0]	0.612	0.716	+ve	-

KPK000250	CX/H/VA/IF/MO/MG	380	3.3	127	134	125-138	129	Very good	Well above	123[0]	118[+]	137[0]	0.913	0.949	+ve	-
KPK000500	CX/H/VA/P/MO/MG	260	9.2	126	120	98-126	115	Good	Better than	111[0]	107[0]	127[-]	0.002	0.012	+ve	Yes
KPK000660	CX/H/VA/P/MO/LG	170	15.5	122	104	71-118	100	Good	Expected	102[0]	101[0]	122[-]	<0.0001	0.0001	+ve	Yes
KPK000880	CW/H/VA/P/MO/LG	60	25.7	89	89	66-101	90	Fair	Better than	91[0]	95[0]	106[-]	0.205	0.355	+ve	-
KPK000990	CW/L/VA/P/HO/LG	5	31.1	91	94	69-98	89	Fair	Better than	85[0]	93[0]	96[-]	0.120	0.232	+ve	-
KTK000150	CW/L/VA/P/HO/LG	420	0	129	139	112-148	138	Very good	Better than	127[+]	132[0]	131[0]	0.709	0.785	-ve	-
KTK000248	WX/L/VA/P/MO/LG	5	18.1	97	107	81-116	103	Good	Better than	85[+]	99[0]	96[0]	0.009	0.034	+ve	Yes
KPA000250	CX/H/VA/P/MO/MG	240	5.7	123	129	83-123	106	Good	Better than	109[0]	112[0]	111[0]	<0.001	0.006	+ve	Yes
KPA000700	CX/H/VA/P/MO/MG	140	13.5	101	95	78-108	92	Fair	Expected	99[0]	103[-]	105[-]	0.047	0.135	+ve	Yes
KPA000950	CX/L/VA/P/MO/LG	20	25.2	93	87	76-98	84	Fair	Expected	86[0]	96[-]	99[-]	0.509	0.662	+ve	-
KRP000300	WX/L/VA/P/LO/LG	180	N/A	99	106	80-100	92	Fair	Expected	103[-]	N/A	92[0]	<0.0001	0.0001	+ve	Yes
KRP000660	WW/L/VA/P/LO/LG	120	N/A	100	100	70-103	91	Fair	Expected	97[0]	N/A	102[-]	0.003	0.014	+ve	Yes
WKR000500	WW/L/VA/P/MO/LG	150	N/A	99	103	88-99	94	Fair	Expected	100[0]	N/A	97[0]	N/A	N/A	N/A	N/A
WKR000700	WW/L/VA/P/MO/LG	70	N/A	103	100	92-97	97	Fair	Better than	92[0]	N/A	95[0]	N/A	N/A	N/A	N/A
TNH000090	WW/L/SS/P/MO/LG	85	N/A	92	97	93-106	98	Fair	N/A	N/A	N/A	110[0]	N/A	N/A	N/A	N/A
TNH000200	WW/L/SS/P/HO/LG	65	N/A	106	108	92-107	106	Good	N/A	N/A	N/A	108[0]	N/A	N/A	N/A	N/A
TNH000515	WW/L/SS/P/HO/LG	15	N/A	104	92	84-96	89	Fair	N/A	N/A	N/A	95[0]	N/A	N/A	N/A	N/A
HRK000085	WW/L/VA/U/MO/MG	5	N/A	84	90	68-96	87	Fair	N/A	N/A	N/A	89[0]	0.942	0.960	+ve	-

Notes:

( ) = affected by recent headwater erosion events

[+/-] = ecologically significant deviation from predicted scores

Trend significant/not significant at $p < 0.05$

N/A = non-ringplain sites

N/A[s] = soft-bedded sites

3 = TRC generic health categories (Table 1)

4 = TRC predictive reach categories (Table 2)

[ ] = assessed on altitude only