Fresh Water Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2010-2011

Technical Report 2011-38
(and Report CF518)

ISSN: 0114-8184 (Print)
ISSN: 1178-1467 (Online)
Document No: 994763

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August 2012

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 2010-2011 monitoring year. Biological surveys were performed in spring (October 2010 through to November 2010) partly and summer (February to mid March 2011), 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 twelfth 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.

For sites located lower in catchments the proportion of 'sensitive' taxa in the macroinvertebrate communities was generally lower in summer than in spring and 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. A number of sites exhibited the typical summer trend of decreased scores, more particularly at mid and lower reach sites, where long term data have indicated lower median summer scores by 3 to 8 units respectively.

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 nine sites have shown very strong improvements and a further six sites, strong improvement, most of which were of ecological significance. Few of these sites were located in the lower reaches of ringplain catchments where the macroinvertebrate communities are very 'tolerant' of the cumulative impacts of organic enrichment. Significant temporal enhancement of (predominantly 'fair') biological stream 'health' at the lowest sites is unlikely to be detected until habitat improvements occur by way of substantial catchment-wide initiatives such as riparian planting and diversion of point source surface water dairy treatment ponds systems wastes discharges to land irrigation.

Substrate instability and sedimentation caused by extensive headwater erosion events in recent years have affected the macroinvertebrate communities at upper sites in the Stony River (in particular), Maketawa Stream, Waiwhakaiho River, Katikara Stream and Timaru Stream in past years. Most of these sites continued to show marked recovery from these impacts over the 2010–2011 period.

The recommendations for the 2011-2012 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 2010-2011 monitoring year, the sixteenth year of this programme.

2. Monitoring activity

2.1 Introduction

The Council commenced the freshwater biological SEM programme in spring 1995. The 2010-2011 monitoring year was therefore the sixteenth year in which this SEM programme was undertaken. This report presents the results from the sites surveyed in the 2010-2011 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). [Note: upper reach gradings have been reassessed and slightly modified for three categories for the purposes of the current and future reporting]

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	125-134	88 – 100	76 – 89
Worse than expected	115-124	73 – 87	60 – 75
Well below expected	<115	<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 SEM sites in the region over the sixteen year period (1995-2011) 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 2010-2011 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 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 E	GPS location N	Distance from Nat Park (km)	Altitude (m asl)	Spring sampling date	Summer sampling date
Conservation	Hangatahua (Stony) R	Mangatete Road	STY000300	1677460	5657823	7.3	160	28 Oct 10	23 Feb 11
	Hangatahua (Stony) R	SH45	STY000400	1674632	5661558	12.5	70	28 Oct 10	23 Feb 11
	Maketawa S	Opp Derby Road	MKW000200	1702192	5656304	2.3	380	8 Nov 10	24 Feb 11
	Maketawa S	Tarata Road	MKW000300	1708784	5665231	15.5	150	8 Nov 10	24 Feb 11
Large catchment/ multiple impacts	Waiwhakaiho R	National Park	WKH000100	1696096	5658351	0	460	2 Nov 10	1 Mar 11
	Waiwhakaiho R	SH3 (Egmont Village)	WKH000500	1698297	5666893	10.6	175	2 Nov 10	1 Mar 11
	Waiwhakaiho R	Constance St (NP)	WKH000920	1695827	2677271	26.6	20	2 Nov 10	1 Mar 11
	Waiwhakaiho R	Adjacent to L Rotomanu	WKH000950	1696587	2678336	28.4	2	2 Nov 10	1 Mar 11
	Mangorei S	SH3	MGE000970	1696094	5671500	21.6	90	2 Nov 10	1 Mar 11
	Manganui R	SH3	MGN000195	1708871	5651282	8.7	330	8 Nov 10	24 Feb 11
	Manganui R	Bristol Road	MGN000427	1711210	5667887	37.9	140	8 Nov 10	24 Feb 11
	Waitara R	Mamaku Road	WTR000850	1708384	5678739	N/A	15	8 Nov 10	24 Feb 11
	Patea R	Barclay Rd	PAT000200	1702620	5646598	1.9	500	10 Nov 10	9 Feb 11
	Patea R	Swansea Rd	PAT000315	17118011	5644382	12.9	300	10 Nov 10	9 Feb 11
	Patea R	Skinner Rd	PAT000360	715919	5644681	19.2	240	10 Nov 10	9 Feb 11
Intensive usage	Waingongoro R	700m d/s Nat Park	WGG000115	1700835	5645086	0.7	540	8 Nov 10	14 Feb 11
	Waingongoro R	Opunake Rd	WGG000150	1705692	5642523	7.2	380	8 Nov 10	14 Feb 11
	Waingongoro R	Eltham Rd	WGG000500	1710576	5634824	23.0	200	8 Nov 10	14 Feb 11
	Waingongoro R	Stuart Rd	WGG000665	1709784	5632049	29.6	180	8 Nov 10	14 Feb 11
	Waingongoro R	SH45	WGG000895	1704042	5618667	63.0	40	8 Nov 10	14 Feb 11
	Waingongoro R	Ohawe Beach	WGG000995	1702531	5617624	66.6	10	8 Nov 10	14 Feb 11
Primary agricultural	Timaru S	Carrington Road	TMR000150	1684423	5659634	0	420	28 Oct 10	23 Feb 11
	Timaru S	SH45	TMR000375	1679509	5665554	10.9	100	28 Oct 10	23 Feb 11
	Mangaoraka S	Corbett Road	MRK000420	1702538	5676320	N/A	60	12 Oct 10	7 Feb 11
	Punehu S	Wiremu Rd	PNH000200	1687323	5637020	4.4	270	3 Nov 10	24 Feb 11
	Punehu S	SH45	PNH000900	1677946	5627786	20.9	20	3 Nov 10	24 Feb 11
	Waiokura S	Skeet Rd	WKR000500	1698807	5628892	N/A	150	3 Nov 10	15 Feb 11
	Waiokura S	Manaia Golf Course	WKR000700	1697636	5622019	N/A	70	3 Nov 10	15 Feb 11
Eastern hill country	Tangahoe R	Upper Valley	TNH000090	1725340	5626101	N/A	85	17 Nov 10	16 Mar 11
	Tangahoe R	Tangahoe Vly Rd bridge	TNH000200	1719126	5622681	N/A	65	17 Nov 10	16 Mar 11
	Tangahoe R	d/s railbridge	TNH000515	1715751	5612470	N/A	15	17 Nov 10	16 Mar 11
	Mangaehu R	Raupuha Rd	MGH000950	1726300	5639062	N/A	120	10 Nov 10	9 Feb 11
Riparian – Western	Waimoku S	Lucy's Gully	WMK000100	1681324	5666240	0	160	28 Oct 10	23 Feb 11
	Waimoku S	Beach	WMK000298	1681725	5669851	4.0	1	28 Oct 10	23 Feb 11
	Katikara S	Carrington Road	KTK000150	1683566	5657855	0	420	4 Nov 10	1 Mar 11
	Katikara S	Beach	KTK000248	1676597	5667473	18.1	5	4 Nov 10	1 Mar 11
	Kapoaiaia S	Wiremu Road	KPA000250	1678009	5652025	5.7	240	4 Nov 10	24 Feb 11
	Kapoaiaia S	Wataroa Road	KPA000700	1672739	5652272	13.5	140	4 Nov 10	24 Feb 11
	Kapoaiaia S	Cape Egmont	KPA000950	1665690	5652452	25.2	20	4 Nov 10	24 Feb 11
Riparian – Southern	Kaupokonui R	Opunake Road	KPK000250	1698088	5639231	3.3	380	3 Nov 10	15 Feb 11
	Kaupokonui R	U/s Kaponga oxi ponds	KPK000500	1698609	5634423	9.2	260	3 Nov 10	15 Feb 11
	Kaupokonui R	U/s Lactose Co.	KPK000660	1697613	5629791	15.5	170	3 Nov 10	15 Feb 11
	Kaupokonui R	Upper Glenn Road	KPK000880	1693026	5622705	25.7	60	3 Nov 10	15 Feb 11
	Kaupokonui R	Near mouth	KPK000990	1691209	5620444	31.1	5	3 Nov 10	15 Feb 11
Small degraded ('poor') catchment	Mangati S	D/s railway line	MGT000488	1700095	5678043	N/A	30	13 Oct 10	21 Mar 11
	Mangati S	Te Rima Pl, Bell Block	MGT000520	1699385	5679103	N/A	20	13 Oct 10	21 Mar 11
	Mangawhero S	u/s Eltham WWT Plant	MWH000380	1712475	5633431	N/A	200	8 Nov 10	11 Feb 11
	Mangawhero S	d/s Mangawharawhara S	MWH000490	1710795	5632738	N/A	190	8 Nov 10	11 Feb 11
	Kurapete S	u/s Inglewood WWT Plant	KRP000300	1705087	5665510	N/A	180	12 Oct 10	7 Feb11
	Kurapete S	6 km d/s Inglewood WWTP	KRP000660	1709239	5667481	N/A	120	12 Oct 10	7 Feb 11
Urbanisation	Huatoki S	Hadley Drive	HTK000350	1693349	5671486	N/A	60	4 Nov 10	1 Mar 11
	Huatoki S	Huatoki Domain	HTK000425	1693041	5673404	N/A	30	4 Nov 10	1 Mar 11
	Huatoki S	Molesworth St	HTK000745	1692800	5676424	N/A	5	4 Nov 10	1 Mar 11
	Herekawe S	Centennial Drive	HRK000085	1688283	5674972	N/A	5	12 Oct 10	1 Mar 11
Northern lowland catchment	Waiau S	Inland North Road	WAI000110	1714587	5680018	N/A	50	12 Oct 10	7 Feb 11
Major abstraction	Waiongana S	SH3a	WGA000260	1705159	5669554	16.1	140	8 Nov 10	24 Feb 11
	Waiongana S	Devon Road	WGA000450	1704063	5680381	31.2	20	8 Nov 10	24 Feb 11

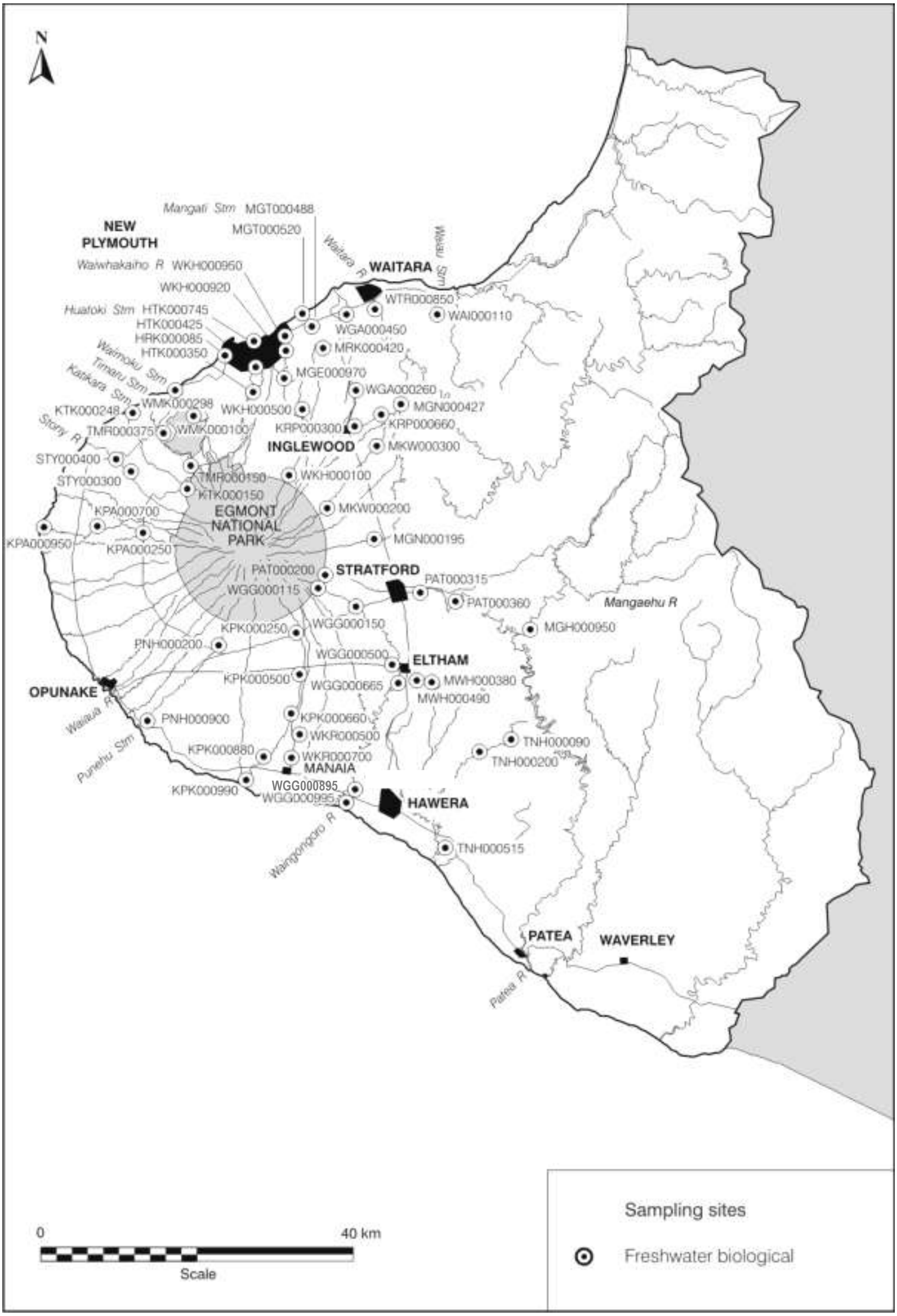


Figure 1 Location of macroinvertebrate fauna sampling sites for the 2010-2011 SEM programme

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 particularly in the Mangatawa Stream, a small lower reach tributary. No industrial discharges to the stream system are known to occur. Both sites were Taranaki ring plain survey sites (TCC, 1984) and the lower site near the coast remains a NIWA hydrological recording station as a representative basin. The upstream site is representative of relatively unimpacted stream water quality although it lies approximately 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 up until mid 2010, received treated industrial and municipal wastes discharges in mid-catchment at Eltham. Site 1 (near the National Park boundary) is representative of high water quality conditions with minimal agricultural impacts. Site 2, six km further downstream (at Opunake Road) represents agricultural impacts, still in the upper reaches of the river while site 3 (at Eltham Road) a further 16 km downstream remains representative of the impacts of farmland drainage and some water abstraction while upstream of the major Eltham point source discharges from a meatworks and the municipal wastewater treatment plant. The meatworks wastewaters were diverted to spring and summer land irrigation in the mid 2000's and the Eltham municipal wastes were diverted by pipeline to Hawera in June 2010. The Stuart Road site, a further six km downstream is located below these discharges with a major portion of the meatworks discharge diverted to land irrigation (spring through late summer) since the early 2000's and the Eltham WWTP discharge diverted out fo the catchment by pipeline to the Hawera WWTP in July 2010. A further two sites (SH45 and Ohawe Beach) located 33 km and 37 km downstream of Stuart Road in the intensively developed farmland lower reaches of the catchment. River flow recording sites are located at Eltham Road and SH45.

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

The Huatoki Stream was sampled as part of the State of the Environment monitoring programme for the first time in the 1997-98 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 Puke Ariki Landing. Within New Plymouth it flows through a culvert in a flood retention dam and over a small weir in the Huatoki Reserve prior to the business section of the city.

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 2010-2011 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	17	17	14	15
Hangatahua (Stony) R	SH45	17	17	14	15
Timaru S	Carrington Road	(17)	(17)	(14)	(15)
Timaru S	SH45	(17)	(17)	(14)	(15)
Mangaoraka S	Corbett Road	8	11	14	41
Waiongana S	SH3a	22	22	31	32
Waiongana S	Devon Road	22	22	31	32
Waiwhakaiho R	National Park	15	16	23	23
Waiwhakaiho R	SH3 (Egmont Village)	15	16	23	23
Waiwhakaiho R	Constance St (NP)	15	16	23	23
Waiwhakaiho R	Adjacent Lake Rotomanu	15	16	23	23
Mangorei S	SH3	(15)	(16)	(23)	(23)
Manganui R	SH3	21	22	30	31
Manganui R	Bristol Road	21	22	30	31
Maketawa S	opp Derby Road	(20)	(21)	(30)	(31)
Maketawa S	Tarata Road	(20)	(21)	(30)	(31)
Waitara R	Mamaku Road	20	21	29	30
Mangati S	D/s railway line	(9)	(12)	(15)	(16)
Mangati S	Te Rima Pl, Bell Block	(9)	(12)	(15)	(16)
Waimoku S	Lucy's Gully	(17)	(17)	(14)	(15)
Waimoku S	Beach	(17)	(17)	(14)	(15)
Waiau S	Inland North Road	(14)	(41)	(8)	(11)
Punehu S	Wiremu Rd	23	33	16	31
Punehu S	SH45	23	33	16	31
Patea R	Barclay Rd	23	24	14	16
Patea R	Swansea Rd	23	24	14	16
Patea R	Skinner Rd	23	24	14	16
Mangaehu R	Raupuha Road	39	39	14	15
Mangawhero S	u/s Eltham WWT Plant	(27)	(-)	(17)	(-)
Mangawhero S	d/s Mangawharawhara S	(27)	(-)	(17)	(-)
Waingongoro R	900m d/s Nat Park	21	22	18	20
Waingongoro R	Opunake Rd	21	22	18	20
Waingongoro R	Eltham Rd	21	22	18	20
Waingongoro R	Stuart Rd	21	22	18	20
Waingongoro R	SH45	21	21	18	20
Waingongoro R	Ohawe Beach	21	21	18	20
Huatoki S	Hadley Drive	(18)	(34)	(20)	(21)
Huatoki S	Huatoki Domain	(18)	(34)	(20)	(21)
Huatoki S	Molesworth St	(18)	(34)	(20)	(21)
Kaupokonui R	Opunake Rd	17	33	21	22
Kaupokonui R	U/s Kaponga oxi ponds	17	33	21	22
Kaupokonui R	U/s Lactose Co.	17	33	21	22
Kaupokonui R	Glenn Rd	17	33	21	22
Kaupokonui R	Beach	17	33	21	22
Katikara S	Carrington Road	(18)	(18)	(20)	(21)
Katikara S	Near mouth	(18)	(18)	(20)	(21)
Kapoaiaia S	Wiremu Road	24	24	15	16
Kapoaiaia S	Wataroa Road	24	24	15	16
Kapoaiaia S	Near coast	24	24	15	16
Kurapete S	u/s Inglewood WWTP	(8)	(11)	(14)	(41)
Kurapete S	6km d/s Inglewood WWTP	(8)	(11)	(14)	(41)
Tangahoe R	Upper Valley	(36)	(46)	(9)	(10)
Tangahoe R	Tangahoe Valley Road	(36)	(46)	(9)	(10)
Tangahoe R	d/s railbridge	(36)	(46)	(9)	(10)
Waiokura S	Skeet Road	(17)	(33)	(21)	(22)
Waiokura S	Manaia Golf-Course	(17)	(33)	(21)	(22)
Herekawe S	Centennial Drive	8	(11)	(20)	(21)
Herekawe S	Centennial Drive	8	(11)	(20)	(21)

NB: ( ) = extrapolation from nearby catchment

Spot water temperatures recorded at each site at the time of sampling during spring 2010 and summer 2011 SEM biomonitoring surveys are summarised in Table 5.

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

Watercourse	Spring 2010	Summer 2011
Hangatahua (Stony) River	13.9-14.9	15.9-16.7
Timaru Stream	12.2-15.1	15.2-17.3
Mangaoraka Stream	10.7	22.5
Waiongana Stream	14.2-16.5	18.5-21.6
Waiwhakaiho River	9.2-16.9	11.9-21.7
Mangorei Stream	14.7	18.1
Manganui River	9.9-14.3	14.2-18.9
Maketawa Stream	10.5-12.2	14.5-16.8
Waitara River	17.5	23.0
Mangati Stream	12.1-13.7	16.2-16.5
Waimoku Stream	12.2-15.8	14.7-18.3
Waiau Stream	12.1	20.1
Punehu Stream	15.0-16.1	15.8-19.4
Patea River	8.3-12.3	12.5-16.0
Mangaehu River	16.7	19.4
Mangawhero Stream	13.8-14.4	17.0-17.8
Waingongoro River	8.7-15.4	15.3-22.4
Huatoki Stream	13.9-14.3	18.2-20.9
Kaupokonui River	10.8-16.4	14.5-20.6
Katikara Stream	10.9-15.6	14.5-20.3
Kapoaiaia Stream	14.9-18.3	17.7-20.9
Kurapete Stream	9.3-9.5	18.3-19.7
Tangahoe River	14.5-15.8	15.0-16.1
Waiokura Stream	12.9-13.6	15.9-17.9
Herekawe Stream	13.2	18.5

(Note: N/R = not recorded)

3.1.1 Water temperature

Spring 2010

Most of the spring 2010 surveys were delayed toward late spring after relatively short to moderate recessions of one to three weeks after freshes. Spring surveys in nearly all streams were conducted from 8 to 20 days after moderate freshes while a few were more than 20 days after freshes. Water temperatures ranged from 8.3˚C to 12.9˚C in the upper reaches; 9.9˚C to 15.0˚C in the middle reaches, and from 10.7˚C to 18.3˚C in the lower reaches of streams and rivers at the time of the surveys (Table 5).

Summer 2011

Generally, rivers and streams were in relatively low recession flow following a few January 2011 freshes but wetter conditions occurred in late February-early March 2011. All but four surveys were performed 14 days to 4 weeks after significant freshes, the majority 14 days or more after a significant (3x median) fresh.

Water temperatures ranged from 11.9°C to 15.2°C in the upper reaches, 14.2°C to 18.5 °C in the mid reaches, and from 16.1°C to 23.0°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 2010 and summer 2011 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. No significant headwater erosion events were recorded in 2009-2010 or 2010-2011. The results of spring (2010) and summer (2010-2011) 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-three surveys have been undertaken in the Stony River at this mid-reach site between October 1995 and February 2010. 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 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
STY000300	33	1-21	10	64-160	113	4	125	11	115

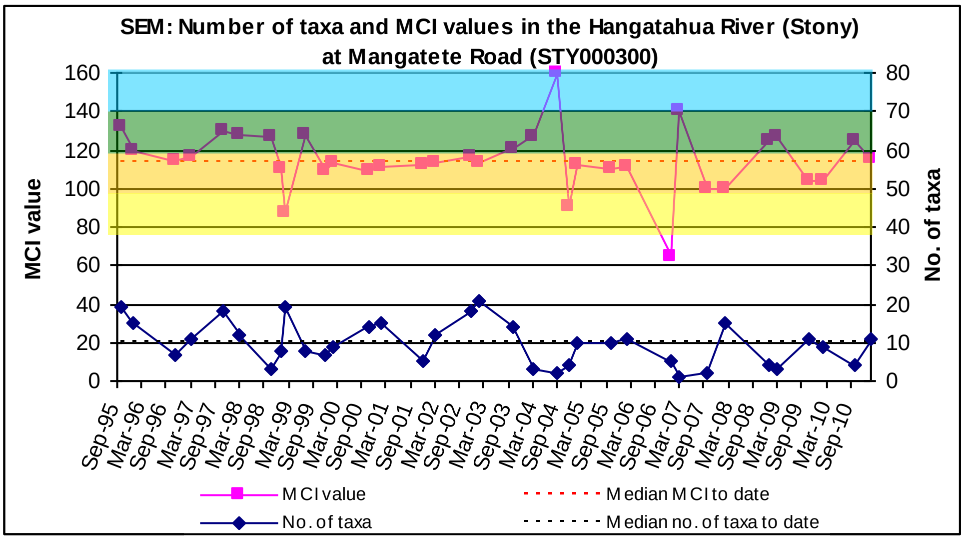


Figure 2 Numbers of taxa and MCI values in the Hangatahua (Stony) River at Mangatete Road

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 2010-2011 period, richness was much lower than this median in spring due to frequent preceeding freshes and headwater erosion during the September-early October period and similar to the median on the summer sampling occasion, 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 2010-2011 scores (125 and 115 units) were above the historical median with the spring score a significant 12 units higher than this historical median. Spring and summer scores respectively categorised this site as having 'very good' and '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 but the paucity of the communities (taxa richness and population numbers), particularly in spring, must be taken into account at the site, where headwater erosion effects have been very pronounced. The historical median score (113 units) also placed this site's river health in the 'good' and 'better than expected' categories.

3.2.1.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 February 2010 [33 surveys] and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	1	3		
EPHEMEROPTERA	*Deleatidium*	8	23	70		VA
PLECOPTERA	*Zelandoperla*	8	9	27		A
COLEOPTERA	Elmidae	6	11	33		
TRICHOPTERA	*Aoteapsyche*	4	3	9		
	Costachorema	7	5	15		
	Hydrobiosis	5	1	3		
	Oxyethira	2	1	3		
DIPTERA	*Aphrophila*	5	1	3		
	Eriopterini	5	4	12		
	Maoridiamesa	3	3	9		
	Orthocladiinae	2	7	21		

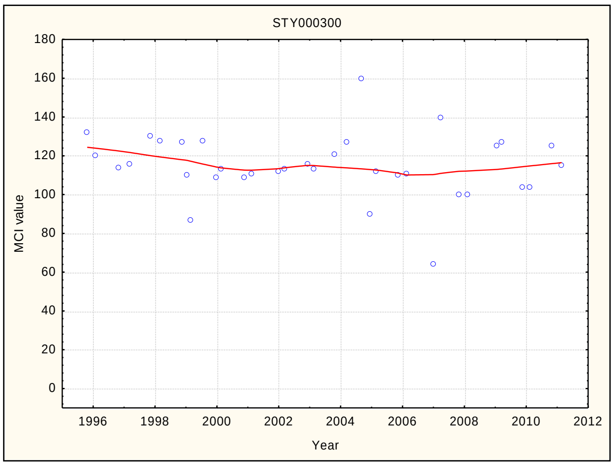
Prior to the current 2010-2011 period, twelve taxa have characterised this site's communities on occasions. These are comprised of two 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa. The only predominant taxon has been the 'highly sensitive' taxon (ubiquitous mayfly (*Deleatidium*)). This taxon and elmid beetles are often present (frequently in large numbers) on unstable shingle-cobble substrates (Death, 2000) and during recovery from erosion/siltation events (Fowles, 1987). None of the characteristic taxa were dominant in the spring community and two of these taxa ('highly sensitive' stonefly, *Zelandoperla* and mayfly, *Deleatidium*) were dominant in the summer community; both these results indicative of the significant reduction in diversity of characteristic taxa due to recent headwater erosion impacts. The lack of abundances of orthoclad midges on both occasions was coincident with the presence of only limited periphyton mats on the cobble-boulder substrate; an indication of minimal recovery from severe scouring/erosion events. The relative lack of characteristic taxa on both occasions was partly reflected in the small difference in $SQMCI_s$ scores of 0.4 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 the spring, 2010 score was significantly higher and summer, 2011 survey score was from 6 to 14 units above predictive values. Of the 35 surveys to date at this site, only 14% of MCI scores have been less than 101 units while 49% have been greater than 109 units.

3.2.1.1.4 Temporal trends in 1995 to 2011 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 = 35
Kendall tau = - 0.167
p level = 0.159 [>FDR, p = 0.266]
N/S at p <0.05

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

Although a slight decreasing trend in MCI scores 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 and further emphasised by the wide range of individual scores, particularly since 2004. 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 varying intervals over the period.

3.2.1.2 SH 45 site (STY000400)

3.2.1.2.1 Taxa richness and MCI

Thirty-three surveys have been undertaken in the Stony River at this lower reach site between October 1995 and February 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
STY000400	33	0-18	8	0-160	108	3	127	13	95

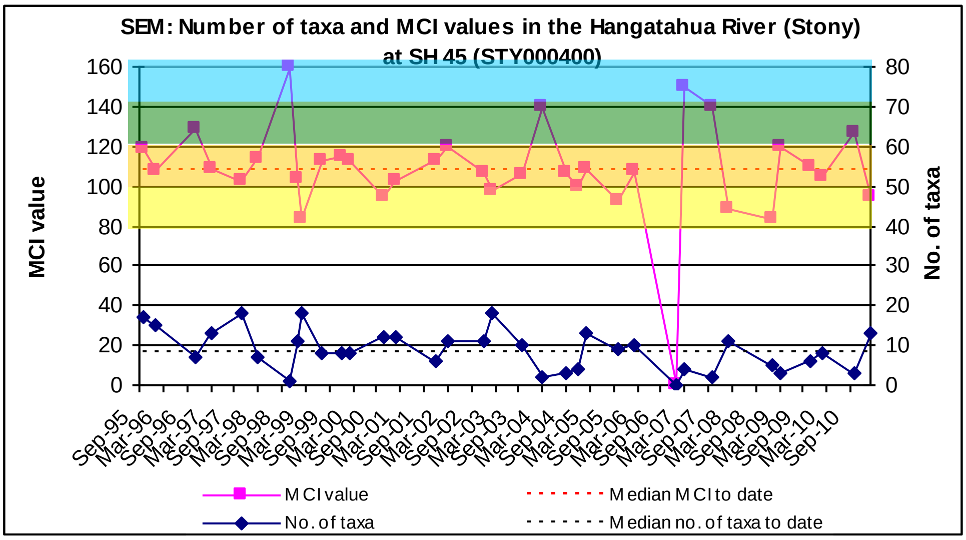


Figure 4 Numbers of taxa and MCI values in the Hangatahua (Stony) River at SH 45

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 8 taxa, far fewer than might be expected for a ringplain river site at this altitude (70 m asl). In the 2010-2011 period richness was well below this median at the time of the spring sampling occasion, indicative of continuing erosion impacts of scouring, finer sediment deposition, and bed movement at this site. Some recovery was indicated by a richness of 13 taxa at the time of the summer survey.

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, 2010 (127 units) and summer, 2011 (95 units) were very different and significantly higher and lower than the historical median respectively (Figure 4). They categorised this site as having 'very good' (spring) and 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'well above expected' health in spring, 2010 and 'better than expected' health in summer, 2011 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. However, the paucity of numbers and richness (particularly in spring) should be recognised in this assessment given the historical impacts of headwater erosion effects along the length of the river channel.

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 February 2010 [33 surveys] and by the spring 2010 and summer 2011

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	1	3		
EPHEMEROPTERA	*Deleatidium*	8	22	67		XA
PLECOPTERA	*Zelandoperla*	8	7	21		
COLEOPTERA	Elmidae	6	5	15		
TRICHOPTERA	*Aoteapsyche*	4	5	15		
	Costachorema	7	4	12		
	Hydrobiosis	5	4	12		
	Oxyethira	2	1	3		
DIPTERA	*Aphrophila*	5	1	3		
	Eriopterini	5	1	3		
	Maoridiamesa	3	3	9		
	Orthocladiinae	2	8	24		

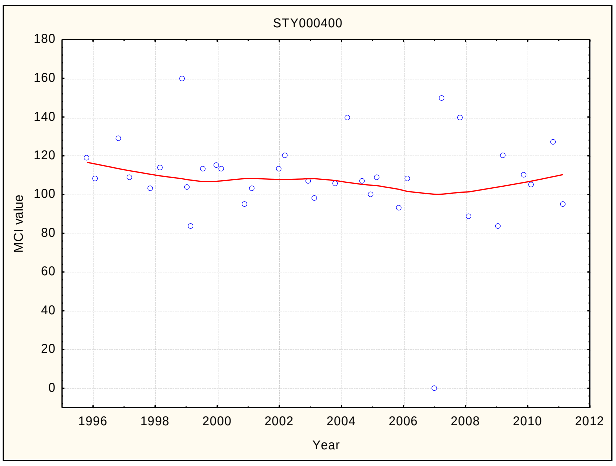
Prior to the current 2010-2011 period, twelve taxa have characterised this site's communities on occasions. These are comprised of two 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa. Only one taxon has been predominant; a 'highly sensitive' taxon (the ubiquitous mayfly (*Deleatidium*)). This taxon is often present on unstable shingle-cobble substrates (Death, 2000) and during recovery from erosion/siltation events (Fowles, 1987). None of the characteristic taxa were dominant in the spring community and only one taxon (*Deleatidium*) was (extremely) abundant in the summer community; both these results indicative of a paucity of characteristic taxa due to preceeding headwater erosion impacts and substrate instability. No abundances of midges occurred in the period despite the presence of patchy periphyton mats in summer on the cobble-boulder substrate. The relative lack of abundant taxa on both occasions was partly reflected in the similarity in $SQMCI_s$ scores (7.3 and 7.5 units) with the slightly higher summer score coincident with the 'highly sensitive' mayfly as 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 the spring, 2010 survey's score was much higher than both predictive values and the summer score was within 8 units of predictive values. Of the 35 surveys to date at this site, only 9% of MCI scores have been less than 92 units while 69% have been greater than 103 units.

3.2.1.2.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 35
Kendall tau = - 0.126
p level = 0.289 [>FDR, p = 0.395]
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' before a further slight improvement. This was a similar trend to that found at the upstream mid-reach (Mangatete Road) site. Greater variability in scores has been apparent since 2004 with the majority of the variability in MCI scores associated with headwater erosion events.

3.2.1.3 Discussion

Due to the major influence of historic and relatively frequent headwater erosion events, scouring, and instability of the river bed; seasonal and spatial differences in macroinvertebrate communities in the Stony River often have not been as pronounced as elsewhere in ringplain streams. Although seasonal MCI values showed a marked difference in spring and summer, with a 32 unit decrease in scores at the downstream site under summer conditions, the paucity of the spring communities at both sites should be noted.

MCI scores atypically increased in a downstream direction in spring but the paucity of these communities influenced this trend. A fall of 20 units in summer over a distance of 5.2 km, equating to a rate of decline of 3.8 units/km, was much higher than the predicted rate (1.15 units/km) over the equivalent length of a National Park-sourced river (Stark and Fowles, 2009), but was influenced by prior headwater erosion events.

3.2.2 Timaru Stream

In the 2008-2009 period severe headwater erosion events had impacted upon the macroinvertebrate communities of the upper reaches of this stream in particular (TRC, 2009). The results found in the 2010-2011 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

Thirty 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 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TMR000150	30	8-32	25	119-144	136	26	125	23	143

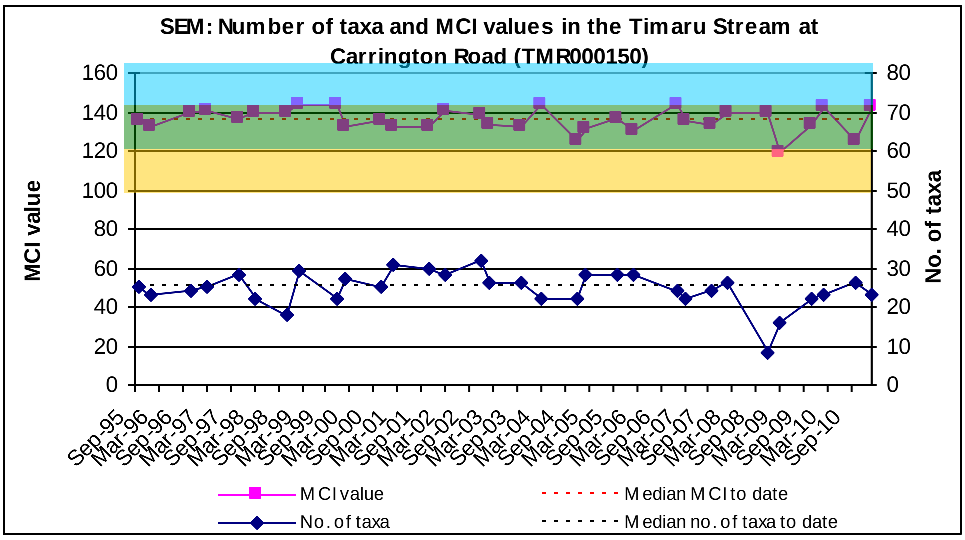


Figure 6 Numbers of taxa and MCI values in the Timaru Stream at Carrington Road

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 (slightly below that representative of typical richnesses in ringplain streams and rivers near the National Park boundary). During the 2010-2011 period, spring (26 taxa) and summer (23 taxa) richnesses were similar to this median richness and indicative of continuing recovery post-headwater erosion events.

MCI values have had a slightly wider range (25 units) at this site than typical of a site near the National Park boundary, 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 although the spring, 2010 score (125 units) was significantly lower than this median, the summer, 2011 score (143 units) was more typical for such a site, and 7 units above the historical median. 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), 'worse than 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 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
EPHEMEROPTERA	*Austroclima*	7	3	10		
	Coloburiscus	7	21	70	A	VA
	Deleatidium	8	30	100	XA	XA
	Nesameletus	9	26	87	VA	VA
PLECOPTERA	*Acroperla*	5	4	13		
	Stenoperla	10	2	7		
	Zelandobius	5	22	73	A	A
	Zelandoperla	8	18	60	XA	VA
COLEOPTERA	Elmidae	6	12	40		
MEGALOPTERA	*Archichauliodes*	7	0	0		A
TRICHOPTERA	*Costachorema*	7	1	3		
	Hydrobiosis	5	1	3		
	Hydrobiosella	9	3	10		
	Orthopsyche	9	2	7		
	Beraeoptera	8	0	0	A	A
	Helicopsyche	10	4	13		
DIPTERA	*Aphrophila*	5	9	30		A
	Maoridiamesa	3	2	7		
	Orthocladiinae	2	17	57		VA

Prior to the current 2010-2011 period, 11 taxa had characterised the community at this site on occasions. These have comprised seven 'highly sensitive', eight '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*)); two 'moderately sensitive' taxa (mayfly (*Coloburiscus*) and stonefly (*Zelandobius*)), and one 'tolerant' taxon (orthoclad midges). Five of these taxa (all 'sensitive' taxa) were dominant in the spring, 2010 community together with a 'highly sensitive' cased caddisfly taxon (*Beraeoptera*) which had not previously been a characteristic taxon. These same taxa were again dominant in the summer, 2011 community together with one of the 'moderately sensitive' historically characteristic taxa of this site (cranefly

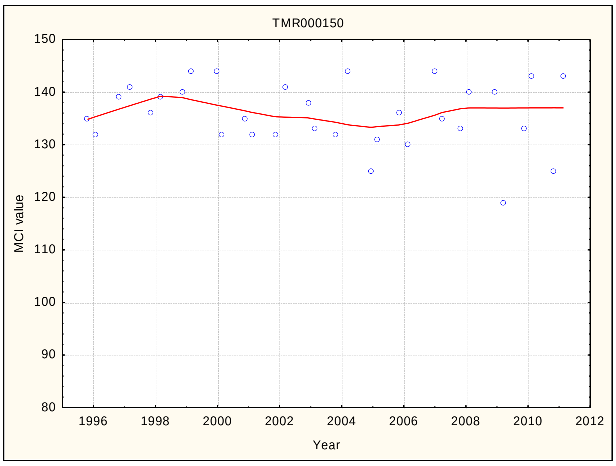
(*Aphrophila*)) and 'tolerant' orthoclad midge taxon; and another 'moderately sensitive' taxon (dobsonfly (*Archichauliodes*)) which, although found at this site previously, had not been a characteristic taxon. No 'tolerant' taxa were dominant at the time of the spring survey but were dominant in summer coincident with patchy periphyton substrate cover at this site. The similarities in characteristic community compositions of extremely and very abundant taxa were reflected in the small seasonal difference of 0.6 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 (125 units) was lower by 2 to 7 units than these predictive values and the summer score (143 units) was significantly higher (Stark, 1998) than both predictive values. Of the 32 surveys to date at this site, only 9% of MCI scores have been less than 127 units while 69% have been greater than 132 units.

3.2.2.1.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = -0.087
p level = 0.482 [>FDR,p = 0.546]
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 sixteen year period.

3.2.2.2 SH45 site (TMR000375)

3.2.2.2.1 Taxa richness and MCI

Thirty surveys have been undertaken in the Timaru Stream at this lower, mid-reach site at SH45 between October 1995 and February 2010. These results are summarised in Table 12, together with the results from the current period, and illustrated in Figure 8.

Table 12 Results of previous surveys performed in the Timaru Stream at SH45, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TMR000375	30	13-33	26	89-120	101	22	115	28	112

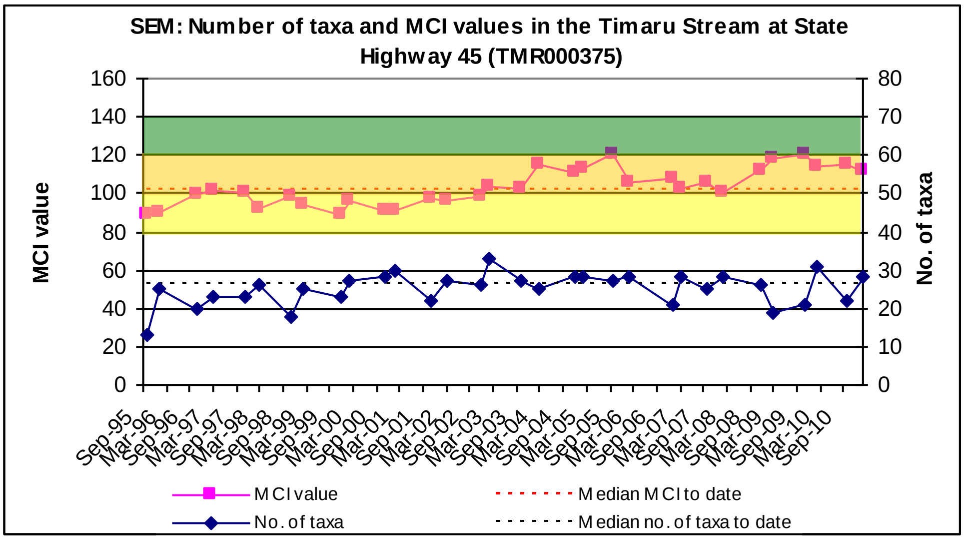


Figure 8 Numbers of taxa and MCI values in the Timaru Stream at State Highway 45

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 2010-2011 period spring (22 taxa) and summer (28 taxa) richnesses were relatively different (by 6 taxa); slightly lower than the median taxa number in spring, but slightly higher than median 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 (101 units) has been relatively typical of mid reach sites elsewhere on the ringplain however, but the spring 2010 (115 units) and summer (112 units) scores were well above those typical for such a site and significantly (Stark, 1998) higher than the historical median by 14 and 11 units respectively. 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 stream. The historical median score (101 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 2010-2011 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 2010 [30 surveys] , and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	1	3		
ANNELIDA	Oligochaeta	1	12	40		A
MOLLUSCA	*Potamopyrgus*	4	4	13		
EPHEMEROPTERA	*Austroclima*	7	9	30	A	
	Coloburiscus	7	17	57	VA	A
	Deleatidium	8	11	37	VA	
	Rallidens	9	1	3		
PLECOPTERA	*Acroperla*	5	5	17		
	Zelandobius	5	1	3	A	
	Zelandoperla	8	11	37	A	A
COLEOPTERA	Elmidae	6	13	43	A	A
MEGALOPTERA	*Archichauliodes*	7	10	33	A	VA
TRICHOPTERA	*Aoteapsyche*	4	27	90	VA	VA
	Costachorema	7	11	37		
	Hydrobiosis	5	7	23		
	Neurochorema	6	5	17		
	Beraeoptera	8	2	7	XA	VA
	Confluens	5	1	3		
	Oxyethira	2	7	23		
	Pycnocentrodes	5	12	40	VA	VA
DIPTERA	*Aphrophila*	5	28	93	A	VA
	Maoridiamesa	3	24	80		
	Orthocladiinae	2	30	100		A
	Tanytarsini	3	6	20		
	Empididae	3	5	17		
	Muscidae	3	4	13		
	Austrosimulium	3	12	40		

Prior to the current 2010-2011 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 no 'highly sensitive' taxa, two 'moderately sensitive' taxa (mayfly (*Coloburiscus*) and cranefly

(*Aphrophila*)), and three 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*)) and midges (*Maoridiamesa* and orthoclads)). Eleven of the historically characteristic taxa were dominant in the spring 2010 community. These comprised three 'highly sensitive', seven 'moderately sensitive', and only one 'tolerant' taxa, whereas two 'highly sensitive',five 'moderately sensitive', and three 'tolerant' taxa comprised the dominant taxa of the summer community when 'tolerant' taxa proportionally were more dominant. Eight of these 13 taxa were dominant in both spring and summer communities (Table 13) but a reduction in numerical dominance of several 'sensitive' taxa and increase in 'tolerant' taxa were reflected in the lower summer seasonal $SQMCI_s$ score (Table 128 and 129) which decreased by 1.4 units.

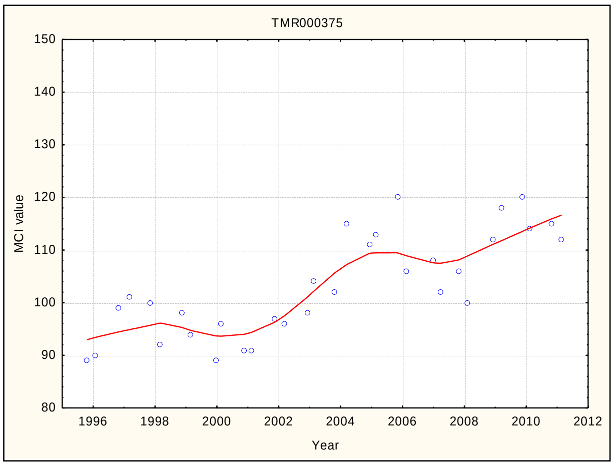
Of note, the 'highly sensitive' flare-cased caddisfly (*Beraeoptera*) had seldom characterised this site's communities on past survey occasions but was particularly dominant in the spring survey and still one of the dominant taxa at the time of the summer survey.

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 (101) is 6 units higher than the altitude prediction and 4 units lower than the distance predictive value. The spring survey score (115 units) was higher than both predictive values while the summer score (112 units) was also higher than predictive values. Of the 32 surveys to date at this site, 22% of MCI scores have been less than 95 units while 41% have been greater than 105 units.

3.2.2.2.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.583
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 markedly between spring and summer at the National Park boundary site whereas a more typical decrease (although only by 3 units) was found at the mid reach site where the percentage composition of 'tolerant' taxa increased slightly in the summer community. Seasonal communities at the upper site shared 19 common taxa (63% of the 30 taxa found at this site in 2010-2011), a lower percentage than normally the case at an upper reach site. This compares with 18 shared common taxa (56% of the 32 taxa found in 2010-2011) at the mid reaches site (SH45), a slightly more pronounced seasonal change in community structure at the further downstream site. The two sites shared only 15 common taxa (47% of the 32 taxa at upper and mid reach sites) in spring and 15 common taxa (42% of 36 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and slightly more so in summer.

MCI score typically fell in a downstream direction in both spring (by 10 units) and more markedly in summer (by 31 units), over a stream distance of 10.9 km downstream from the National Park boundary. These equated to rates of decline of 0.9 unit/km in spring increasing to 2.8 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 3.0 units/km over the surveyed length. Therefore rates of decline were far lower in spring and slightly lower in summer of the 2010–2011 period than the average rate for the period to date.

3.2.3 Mangaoraka Stream

The results found by the 2010-2011 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

Thirty surveys have been undertaken at this lower reach site in the Mangaoraka Stream between October 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MRK000420	30	11-30	25	75-105	89	24	103	25	90

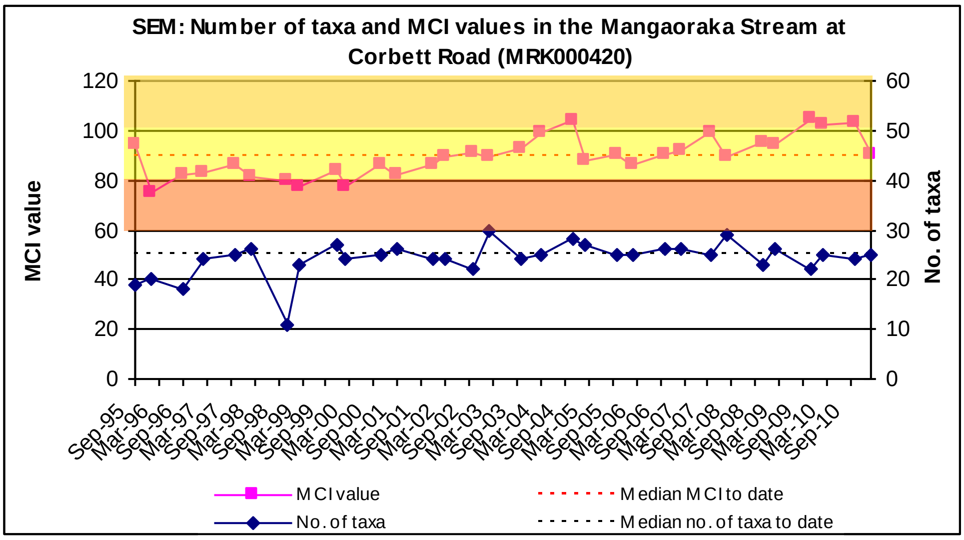


Figure 10 Numbers of taxa and MCI values in the Mangaoraka Stream at Corbett Road

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 the lower reaches of ringplain streams rising outside the National Park boundary). During the 2010-2011 period spring (24 taxa) and summer (25 taxa) richnesses were very similar and slightly lower than or equivalent to this median richness.

MCI values have had a relatively wide range (30 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 (103 units) score was higher than typical for such a site and significantly (Stark, 1998) 14 units above the historical median, while the summer value (90 units) was almost identical to the historical median. The spring value was only two MCI units below the previous maximum 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' (spring) and 'expected' (summer) health for the lower reaches of a ringplain stream on 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 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
PLATYHELMINTHES	*Cura*	3	1	3		
NEMERTEA	Nemertea	3	4	13		
ANNELIDA	Oligochaeta	1	23	77	A	
MOLLUSCA	*Latia*	5	2	7		
	Physa	3	1	3		
	Potamopyrgus	4	26	87	A	XA
CRUSTACEA	Ostracoda	1	1	3		
EPHEMEROPTERA	*Austroclima*	7	16	53	A	VA
	Coloburiscus	7	4	13		
	Deleatidium	8	2	7	A	
	Zephlebia group	7	2	7	A	
PLECOPTERA	*Zelandobius*	5	11	37	A	
COLEOPTERA	Elmidae	6	18	60	VA	XA
MEGALOPTERA	*Archichauliodes*	7	11	37	A	A
TRICHOPTERA	*Aoteapsyche*	4	25	83	A	XA
	Costachorema	7	2	7		
	Hydrobiosis	5	22	73		VA
	Neurochorema	6	2	7		
	Oxyethira	2	6	20		
	Pycnocentria	7	2	7		
	Pycnocentrodes	5	21	70	A	VA
DIPTERA	*Aphrophila*	5	16	53		A
	Maoridiamesa	3	8	27		A
	Orthocladiinae	2	25	83		A
	Tanytarsini	3	7	23		A
	Empididae	3	4	13		
	Muscidae	3	2	7		
	Austrosimulium	3	10	33		

Prior to the current 2010-2011 period, 28 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', 13 'moderately sensitive', and 14 'tolerant' taxa i.e a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream.

Predominant taxa have included five 'moderately sensitive' taxa (mayfly (*Austroclima*), elmid beetles, free-living caddisfly (*Hydrobiosis*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)), and four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and orthoclad midges).

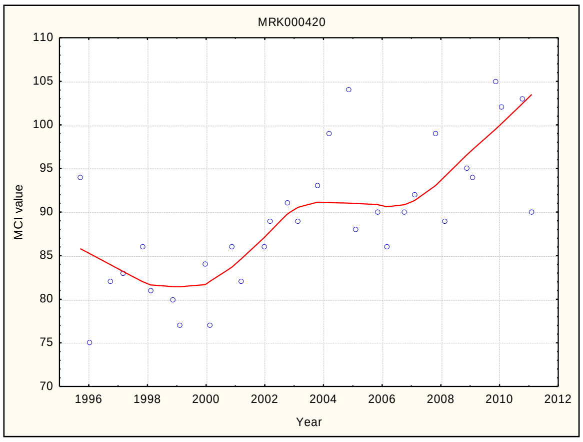
Ten of the historically characteristic taxa were dominant in the spring, 2010 community and comprised six of the predominant taxa (above) together with one 'highly sensitive' and three 'moderately sensitive' taxa. The summer, 2011 community was characterised by six of the taxa dominant in spring, together with an additional two 'moderately sensitive' and three 'tolerant' (midge) taxa, all of which previously had been characteristic of this site's communities (Table 15). The increase in 'tolerant' summer dominant taxa was reflected in the decrease in $SQMCI_s$ scores of 0.7 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 53% to 87% 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 the spring survey score (103 units) was significantly higher (Stark, 1998) and the summer score very similar to the predictive value. Of the 32 surveys to date at this site, 75% of MCI scores have been less than 91 units, indicating that the current spring MCI score was not typical of historical conditions.

3.2.3.1.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = + 0.562
p level < 0.0001 [>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 21 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 (i.e. increased bacteriologtical numbers and increasing trends in certain nutrient species) 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 most of the period improving to 'good' recently 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 sixteen year period.

3.2.3.2 Discussion

Seasonal MCI values typically decreased between spring and summer (by 13 units) at this lower reach site where the percentage composition of 'tolerant' taxa increased by a significant 19% in the summer community when periphyton mats and filamentous algal substrate cover was much more pronounced under much warmer water temperature conditions. Seasonal communities at this site shared 19 common taxa (63% of the 30 taxa found at this site in 2010-2011), but the significant increase in the proportion of 'tolerant' taxa in summer resulted in a decrease of 13 units in MCI values between seasons.

3.2.4 Waiongana Stream

The results found by the 2010-2011 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

Thirty-one surveys have been undertaken at this mid reach site in the Waiongana Stream between October 1995 and March 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to March 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGA000260	31	12-30	24	82-112	95	22	95	27	98

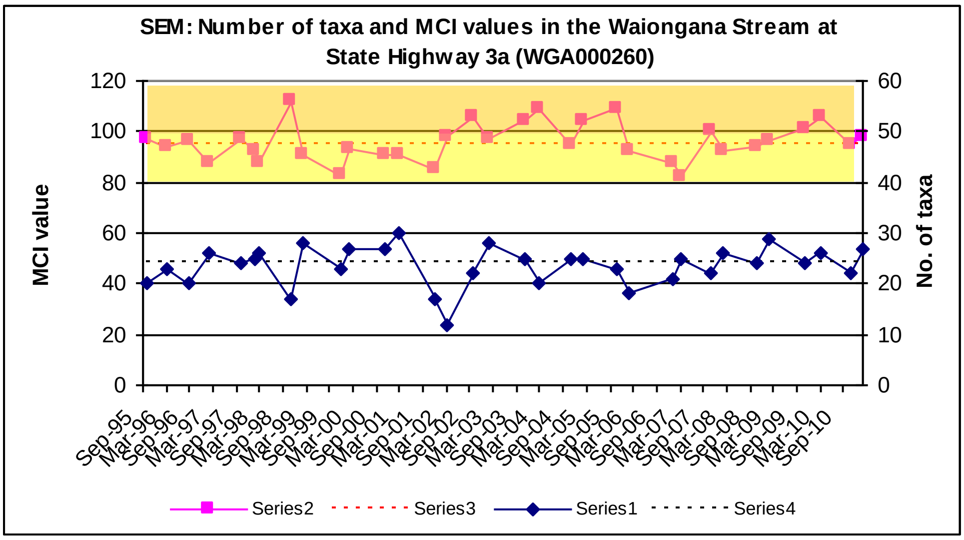


Figure 12 Numbers of taxa and MCI values in the Waiongana Stream at State Highway 3A

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 2010-2011 period, spring (22 taxa) and summer (27taxa) richnesses increased in summer but were relatively 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 (95 units) also has been typical of mid-reach sites elsewhere on the ringplain, and the spring, 2010 (95 units) and summer, 2011 (98 units) scores were equal with and 3 units above the historical median respectively. 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), 'expected' health for the mid reaches of a ringplain stream on both of these occasions. The historical median score (95 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 2010-2011 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 March 2010 [31 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	2	6		
ANNELIDA	Oligochaeta	1	17	55		
MOLLUSCA	*Potamopyrgus*	4	11	35		A
CRUSTACEA	*Paracalliope*	5	1	3		
EPHEMEROPTERA	*Austroclima*	7	2	6		A
	Coloburiscus	7	3	10		
	Deleatidium	8	12	39	VA	VA
COLEOPTERA	Elmidae	6	22	71	A	VA
MEGALOPTERA	*Archichauliodes*	7	7	23		A
TRICHOPTERA	*Aoteapsyche*	4	20	65		VA
	Costachorema	7	8	26		
	Hydrobiosis	5	14	45		A
	Neurochorema	6	2	6		
	Oxyethira	2	9	29		
	Pycnocentrodes	5	7	23		A
DIPTERA	*Aphrophila*	5	25	81	A	VA
	Maoridiamesa	3	20	65	A	
	Orthocladiinae	2	27	87	XA	VA
	Tanytarsini	3	11	35		VA
	Empididae	3	6	19		
	Muscidae	3	6	19		
	Austrosimulium	3	3	10		

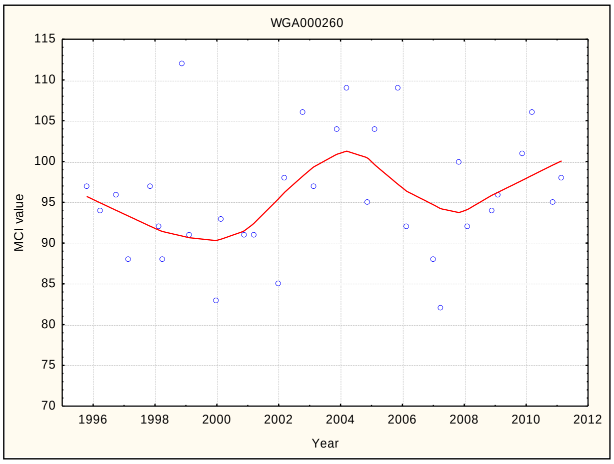
Prior to the current 2010-2011 period, 22 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and eleven 'tolerant' taxa i.e. a relatively even balance of 'sensitive' and 'tolerant' taxa as would be expected in the mid-reaches of a ringplain stream. Predominant taxa have included two 'moderately sensitive' taxa (elmid beetles and cranefly (*Aphrophila*)); and four 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)). Four of these predominant taxa were dominant in the spring, 2010 community together with one of the other historically characteristic taxa. The summer, 2011 community was characterised by four of the taxa dominant in spring, together with an additional four 'moderately sensitive' and three 'tolerant' taxa, all of which previously had been characteristic of this site's communities on occasions (Table 17). An atypical decrease in the numerical abundance of orthoclad midges in particular was reflected in the increase of 1.6 units in $SQMCI_s$ scores between seasons (Tables 132 and 133). All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 35% to 87% 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 (95 units) is 4 units lower than the altitude prediction and 5 units below the distance predictive value, while the spring, 2010 survey score (95 units) was lower by 4 to 5 units than both predictive values while the summer, 2011 score (98 units) was within 1 to 2 units of both predictive values. Of the 33 surveys to date at this site, 73% of MCI scores have been less than 99 units while only 21% have been greater than 100 units.

3.2.4.1.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 33
Kendall tau = + 0.149
p level = 0.224 [>FDR, p = 0.328]
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 has been 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 in the 'expected' category almost throughout the sixteen year period, bordering on 'better than expected' for short periods in 2003-2005 and most recently in 2010-2011.

3.2.4.2 Devon Road site (WGA000450)

3.2.4.2.1 Taxa richness and MCI

Thirty surveys have been undertaken at this lower reach site at SH45 in the Waiongana Stream between October 1995 and March 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGA000450	30	12-29	22	72-102	85	22	95	21	90

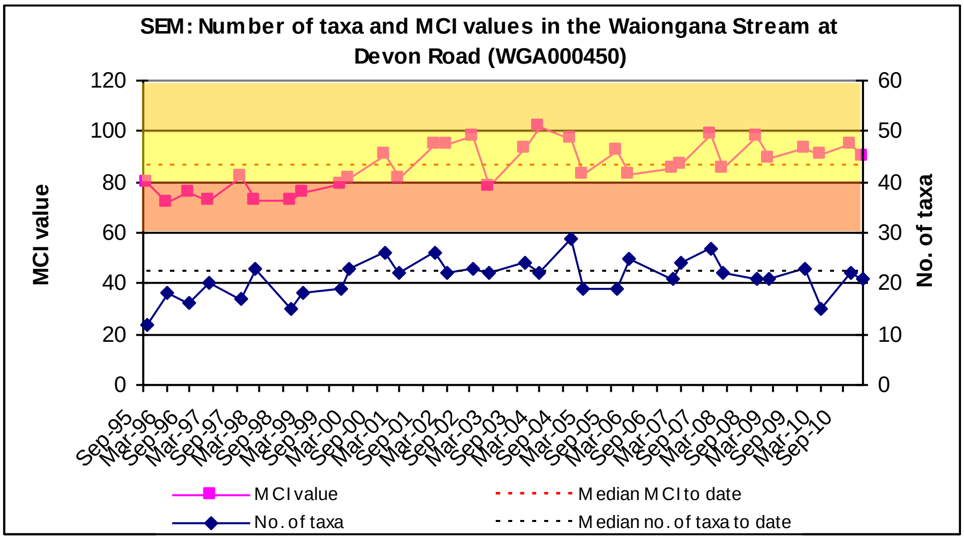


Figure 14 Numbers of taxa and MCI values in the Waiongana Stream at Devon Road

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 2010-2011 period, spring (22 taxa) and summer (21 taxa) richnesses very similar and also very similar to the median taxa number in spring and in summer.

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 (85 units) has been relatively typical of lower reach sites elsewhere on the ringplain however, but the spring, 2010 (95 units) and summer, 2010 (90 units) scores were within the range typical for such a site and higher than the historical median by 10 and 5 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 (85 units) placed this site in the 'fair' category for generic and 'expected' category for predictive methods of assessment.

3.2.4.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 March 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	3	10		
ANNELIDA	Oligochaeta	1	24	80	A	VA
MOLLUSCA	*Ferrissia*	3	1	3		
	Latia	5	2	7		
	Potamopyrgus	4	18	60	A	VA
CRUSTACEA	*Paracalliope*	5	2	7		
	Paratya	3	1	3		
EPHEMEROPTERA	*Austroclima*	7	4	13		
	Deleatidium	8	4	13	A	
PLECOPTERA	*Zelandobius*	5	0	0	A	
COLEOPTERA	Elmidae	6	11	37	VA	VA
MEGALOPTERA	*Archichauliodes*	7	5	17		A
TRICHOPTERA	*Aoteapsyche*	4	19	63	A	VA
	Costachorema	7	2	7		
	Hydrobiosis	5	12	40		
	Oxyethira	2	8	27		
	Pycnocentrodes	5	13	43	A	
DIPTERA	*Aphrophila*	5	14	47		
	Maoridiamesa	3	13	43	A	
	Orthocladiinae	2	26	87	VA	VA
	Tanytarsini	3	10	33		A
	Empididae	3	1	3		
	Muscidae	3	3	10		
	Austrosimulium	3	6	20		

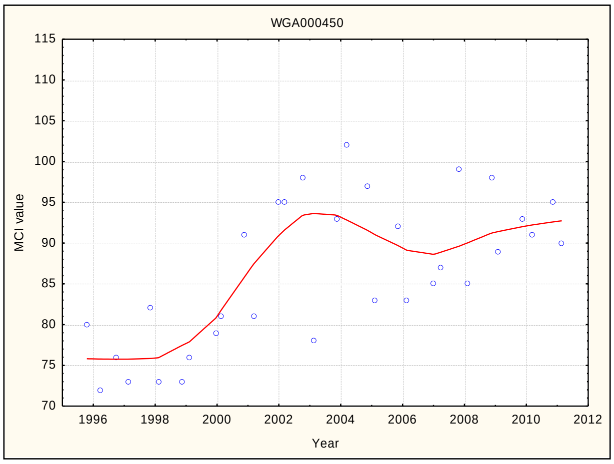
Prior to the current 2010-2011 period 23 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', nine 'moderately sensitive', and 13 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly sensitive' taxa; no 'moderately sensitive' taxa; and four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and orthoclad midges). Eight of the historically characteristic taxa were dominant in the spring 2010, community together with one 'moderately sensitive' taxon (stonefly (*Zelandobius*)) which, although present occasionally, had not been a characteristic taxon previously. These comprised two 'moderately sensitive' and five 'tolerant' taxa, whereas two 'moderately sensitive' and five 'tolerant' taxa comprised the dominant taxa in the summer community. Five of these 11 taxa were dominant in both spring and summer communities (Table 19). The increased numerical abundances within several 'tolerant' taxa in summer were reflected in the lower (by 0.6 unit) $SQMCI_s$ score at that time (Tables 132 and 133). All taxa recorded as very or extremely abundant during spring and /or summer had characterised this site's communities on 37% to 87% 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 (85 units) is slightly lower (by 1 unit) than the altitude prediction and 8 units lower than the predictive distance value, while the spring, 2010 survey score (95 units) was slightly higher than these predictive values. The summer, 2011 score (90 units) was higher than the predictive altitude value. Of the 32 surveys to date at this site 50% of MCI scores have been less than 86 units while only 25% have been greater than 93 units.

3.2.4.2.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = + 0.472
p level < 0.0002 [>FDR, p = 0.0011]
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 lower 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 almost without exception since 2002.

3.2.4.3 Discussion

Seasonal MCI values atypically remained equal between spring and summer at the mid- reach (SH3a) site whereas a more typical decrease (of 8 units) was found at the lower reach site where the percentage composition of 'tolerant' taxa increased (by 11%) in the summer lower reach community. Seasonal communities at the mid-reach site (SH3a) shared 18 common taxa (58% of the 31 taxa found at this site in 2010-2011) compared with 17 shared common taxa (65% of the 26 taxa found in 2010-2011) 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 (52% of the 29 taxa) in spring and only 18 common taxa (60% of 30 taxa) in summer, indicative of greater dissimilarity in spatial community structures in spring than in summer.

MCI score atypically remained the same in a downstream direction in spring and more typically fell in summer (but only by 5 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 nil units/km in spring increasing to 0.3 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 2010–2011 period were lower in both spring and summer than the average 2011 historical rate.

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 2010-2011 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

Sixteen surveys have been undertaken at this upper reach site just inside the National Park boundary in the Waiwhakaiho River between November 2002 and March 2010. 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 2010 and summer 2011 results

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		March 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000100	16	4-29	20	115-146	127	19	140	17	126

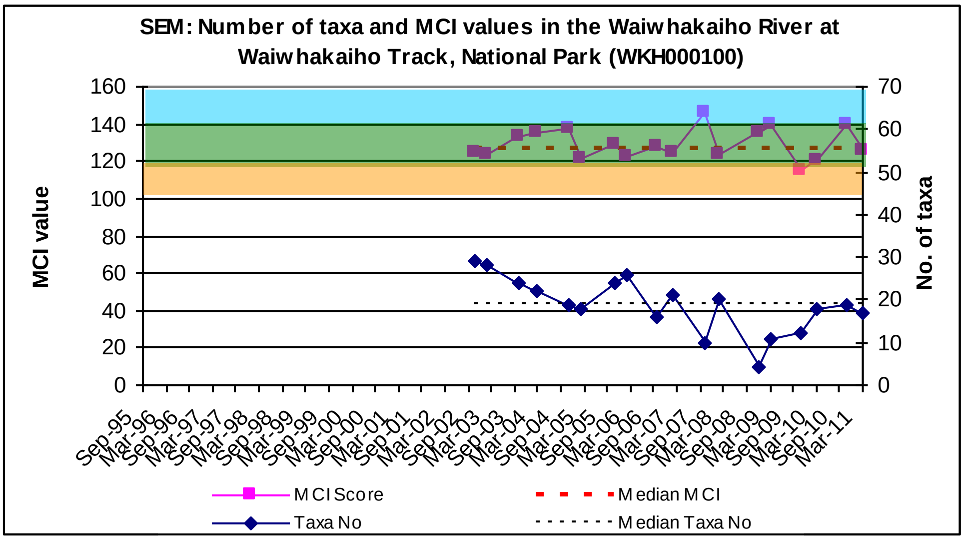


Figure 16 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmond National Park

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 20 taxa, but lower than typical richnesses in ringplain streams and rivers near the National Park boundary. During the 2010-2011 period spring (19 taxa) and summer (17 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 wider range (31 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 (127 units) has been slightly lower than typical of upper reach sites elsewhere on the ringplain, and the spring, 2010 (140 units) and summer, 2010 (126 units) scores continued this atypical trend of wide ranging scores for such a site. These scores were 13 units higher and 1 unit below the historical median respectively. They categorised this site as having 'very good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' to '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 (127 units) placed this site in the 'very good' and '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 2010-2011 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 2002 and March 2010 [14 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
EPHEMEROPTERA	*Coloburiscus*	7	2	13		
	Deleatidium	8	16	100	VA	XA
	Nesameletus	9	4	25		
PLECOPTERA	*Megaleptoperla*	9	6	38		
	Zelandoperla	8	11	69	A	VA
COLEOPTERA	Elmidae	6	14	88	VA	VA
TRICHOPTERA	*Aoteapsyche*	4	1	6		
	Costachorema	7	1	6		
	Hydrobiosella	9	1	6		
	Beraeoptera	8	4	25	A	
DIPTERA	*Aphrophila*	5	7	44		A
	Eriopterini	5	3	19		
	Maoridiamesa	3	1	6		
	Orthocladiinae	2	2	13		

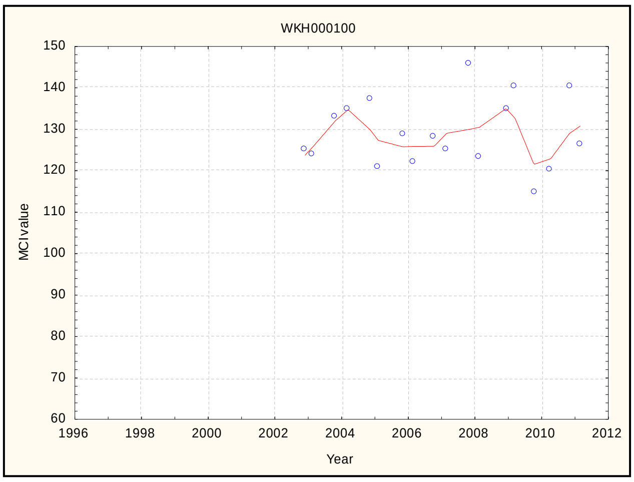
Prior to the current 2010-2011 period, 14 taxa had characterised the community at this site on occasions. These have comprised six 'highly sensitive', five 'moderately sensitive', and three 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected near the National Park boundary of a ringplain stream. Predominant taxa have included two 'highly sensitive' taxa (mayfly (*Deleatidium*) on every sampling occasion and stonefly (*Zelandoperla*)); one 'moderately sensitive' taxon (elmid beetles); but no 'tolerant' taxa. Three of these taxa were dominant in the spring 2010 community together with one additional 'highly sensitive' taxon.. These same taxa were again dominant in the summer 2011 community together with another of the 'moderately sensitive' historically characteristic taxa of this site (elmid beetles). 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 69% to 100% of past surveys.

3.2.5.1.3 Predicted stream 'health'

The Waiwhakaiho River site at the National Park is just inside the National Park boundary at an altitude of 460 m asl. Relationships for ringplain streams developed between MCI and 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 (127 units) is only 4 units lower than the altitude prediction and 5 units lower than the distance predictive value, while the spring, 2010 survey score (140 units) was higher than both predictive values while the summer, 2011 score (126 units) was five to six units lower than both predictive values. Of the 18 surveys to date at this site, 61% of MCI scores have been less than 131 units while 39% have been greater than 132 units.

3.2.5.1.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the nine 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 = 18
Kendall tau = +0.013
p level = 0.939 [>FDR, p = 0.939]
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 nine 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 remained within the 'expected' category through the nine year period.

3.2.5.2 Egmont Village site (WKH000500)

3.2.5.2.1 Taxa richness and MCI

Thirty surveys have been undertaken in the Waiwhakaiho River at this mid-reach site at SH 3, Egmont Village between October 1995 and March 2010. 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 2010, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		March 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000500	30	14-32	23	87-122	108	17	119	24	117

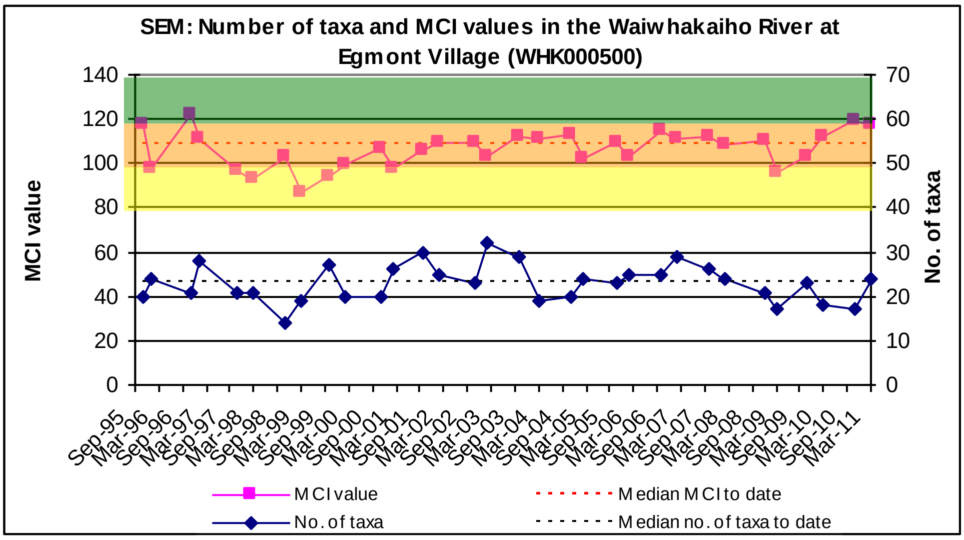


Figure 18 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont Village

A wide range of richnesses (14 to 32 taxa) has been found; wider than might be expected, with a median richness of 23 taxa (more representative of typical richnesses in the mid reaches of ringplain streams and rivers). During the 2010-2011 period spring (17 taxa) and summer (24 taxa) richnesses were quite different (by 7 taxa); below the median taxa number in spring when substrate periphyton cover was more extensive than usual, but near the median richness in summer.

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, 2010 (119 units) and summer, 2010 (117 units) scores slightly higher than typical for such a site and 9 to 11 units higher than 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 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMATODA	Nematoda	3	1	3		
ANNELIDA	Oligochaeta	1	8	27		
EPHEMEROPTERA	*Coloburiscus*	7	9	30		
	Deleatidium	8	23	77	XA	XA
	Nesameletus	9	3	10		
PLECOPTERA	*Zelandoperla*	8	1	3		
COLEOPTERA	Elmidae	6	16	53	A	VA
MEGALOPTERA	*Archichauliodes*	7	2	7		
TRICHOPTERA	*Aoteapsyche*	4	19	63		VA
	Costachorema	7	9	30		A
	Hydrobiosis	5	4	13		A
	Neurochorema	6	5	17		
	Beraeoptera	8	1	3		
	Oxyethira	2	8	27		
	Pycnocentrodes	5	3	10		
DIPTERA	*Aphrophila*	5	25	83		VA
	Eriopterini	5	2	7		
	Maoridiamesa	3	26	87		VA
	Orthocladiinae	2	28	93	VA	VA
	Tanytarsini	3	10	33		
	Empididae	3	2	7		
	Muscidae	3	4	13		
	Austrosimulium	3	1	3		

Prior to the current 2010-2011 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 a (downstream) increase in 'tolerant' taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); two 'moderately sensitive' taxa (elmid beetles and cranefly (*Aphrophila*)); and three 'tolerant' taxa (free-living caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)). Three of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive' taxon, one 'moderately sensitive' taxon, and one 'tolerant' taxon, whereas one 'highly sensitive', four 'moderately sensitive', and three 'tolerant' taxa comprised the dominant taxa of the summer community. Three of these eight taxa were dominant in both spring and summer communities (Table 23). Increased dominances by 'tolerant' taxa in summer were reflected in the decrease of 0.9 in $SQMCI_s$ scores between spring and summer (Tables 134 and 135).

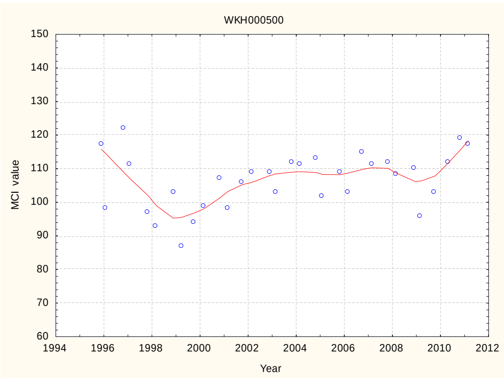
The ‘highly sensitive’ mayfly (*Deleatidium*), ‘moderately sensitive’ elmid beetles, and ‘tolerant’ midges (orthoclads) have characterised this site’s communities on 53% to 93% of past survey occasions and were dominant in both the spring and summer surveys.

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, 2010 survey score (119 units) was significantly higher (Stark, 1998) than both predictive values and the summer, 2011 score (117 units) was also significantly higher than both predictive values by 12 to 15 units. Of the 32 surveys to date at this site, 25 % of MCI scores have been less than 102 units while 59% have been greater than 105 units.

3.2.5.2.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.273
p level = 0.0028 [>FDR, p = 0.0081]
Significant at p < 0.05 and after FDR

Figure 19 LOWESS trend plot at the Egmont Village site

An overall significant trend in MCI scores has been found during the sixteen year period. After some initial deterioration in scores, there has been a steady improvement since 1999. The LOWESS-smoothed range (22 MCI units) has been of 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

Thirty-one surveys have been undertaken in the Waiwhakaiho River at this lower reach site at Constance Street, New Plymouth between 1995 and March 2010. 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 2010, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		March 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000920	31	12-29	21	71-108	94	16	110	19	88

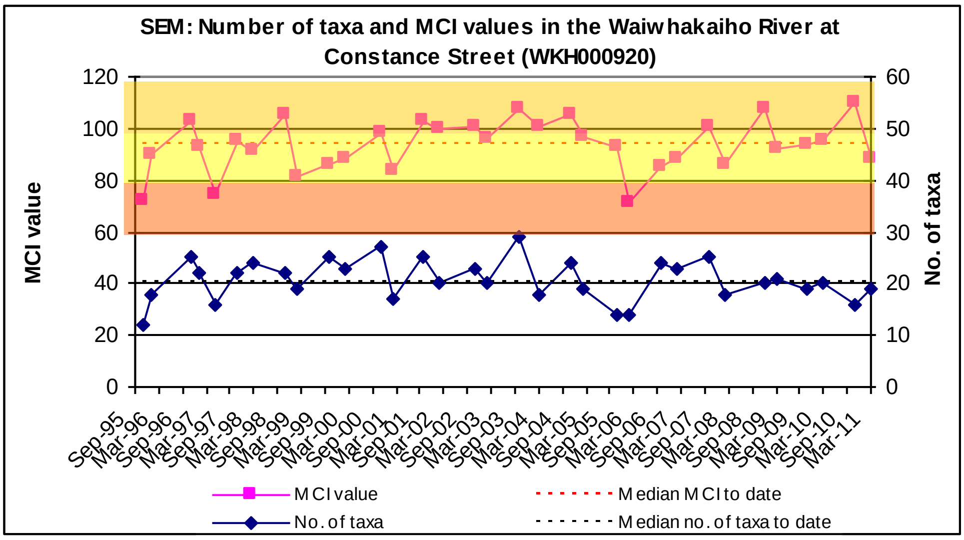


Figure 20 Numbers of taxa and MCI values in the Waiwhakaiho River at Constance Street

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 2010-2011 period spring (16 taxa) and summer (19 taxa) richnesses were relatively similar and 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 (94 units) has been relatively typical of the range of scores at lower reach sites elsewhere on the ringplain however. The spring, 2010 (110 units) and summer, 2011 (88 units) scores significantly different (Stark, 1998) but relatively typical of scores for such a site. They were significantly higher than the historical median in spring and lower in summer. The spring score also was 2 units higher than the maximum previously recorded at the 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), 'well above expected' and 'expected' health in spring and summer respectively for the lower reaches of a ringplain river. The historical median score (94 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 2010-2011 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 2010 [31 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	1	3		
ANNELIDA	Oligochaeta	1	19	61		
MOLLUSCA	*Potamopyrgus*	4	2	6		
CRUSTACEA	*Paratya*	3	1	3		
EPHEMEROPTERA	*Austroclima*	7	0	0		A
	Coloburiscus	7	5	16		
	Deleatidium	8	13	42	VA	A
COLEOPTERA	Elmidae	6	5	16	A	A
	Staphylinidae	5	1	3		
TRICHOPTERA	*Aoteapsyche*	4	24	77		VA
	Costachorema	7	5	16		
	Hydrobiosis	5	6	19		
	Neurochorema	6	1	3		
	Oxyethira	2	10	32		
DIPTERA	*Aphrophila*	5	7	23		
	Maoridiamesa	3	15	48		
	Orthocladiinae	2	30	97	A	VA
	Tanytarsini	3	15	48		
	Muscidae	3	2	6		
	Austrosimulium	3	4	13		

Prior to the current 2010-2011 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 no 'highly sensitive' or 'moderately sensitive' taxa and three 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and orthoclad midges). Only three of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive' taxon, one 'moderately sensitive' taxon and one 'tolerant' taxon, whereas one 'highly sensitive', one 'moderately sensitive', and two 'tolerant' taxa comprised the dominant taxa of the summer, 2011 community together with one 'moderately sensitive' taxon (mayfly (*Austroclima*)) not previously found as dominant at this site. Three of these five taxa were dominant in both spring and summer communities (Table 25). Increased summer seasonal dominances by 'tolerant' taxa were reflected in the marked decrease (2.6 units) in the summer $SQMCI_s$ score (Tables 134 and 135).

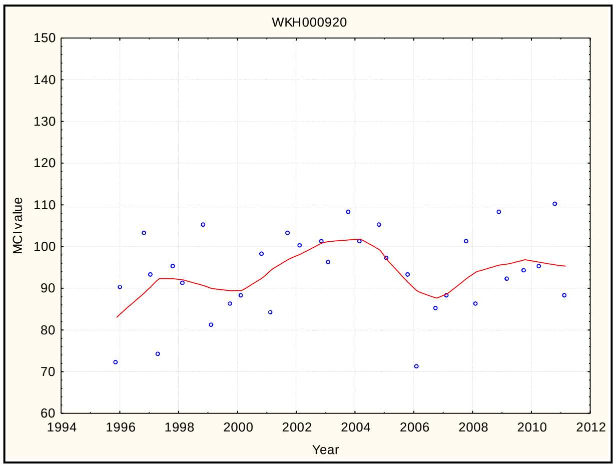
The 'highly sensitive' mayfly (*Deleatidium*), 'moderately sensitive' elmid beetles, and 'tolerant' orthoclad midges and caddisfly (*Aoteapsyche*) which were dominant in both spring and summer surveys have characterised this site's communities on 16% to 97% of past survey occasions.

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 (94) is 8 units higher than the altitude prediction and only one unit lower than the distance predictive value. The spring, 2010 survey score (110 units) was a significant 24 and 15 units higher than the altitude and distance predictive values respectively while the summer, 2010 score (88 units) was two units higher than the predictive altitude value and seven units lower than the predicted distance value. Of the 33 surveys to date at this site, 18% 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 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 33
Kendall tau = +0.147
p level = 0.246 [>FDR, p = 0.346]
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 some decline in more recent scores. The LOWESS-smoothed range of scores (18 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 six 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-nine surveys have been undertaken in the Waiwhakaiho River at this lower reach site adjacent to Lake Rotomanu between March 1997 and March 2010. 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 2010 and summer 2011 results

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		March 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000950	29	12-27	21	70-111	88	24	105	17	84

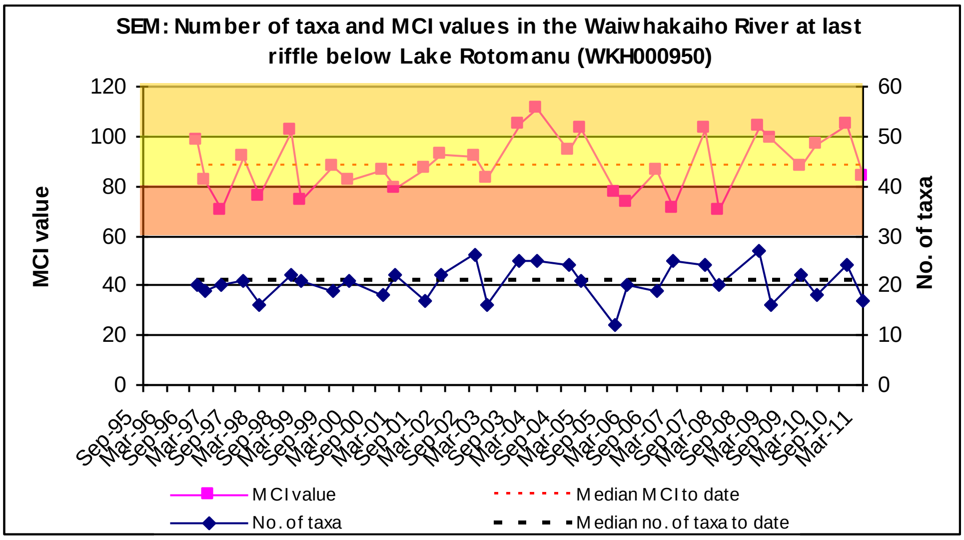


Figure 22 Numbers of taxa and MCI values in the Waiwhakaiho River at Lake Rotomanu

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 2010-2011 period spring (24 taxa) richness was 7 taxa higher than found later in summer but richnesses were within four 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 (88 units) has been relatively typical of lower reach sites elsewhere on the ringplain. The spring 2010 (105 units) and summer, 2010 (84 units) scores, although typical for such a site, were significantly higher (in spring) and four units lower in summer than the historical median. 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 in spring and 'expected' health in summer for the lower reaches of a ringplain river. The historical median score (88 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 1997 and March 2010 [29 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	3	10		
ANNELIDA	Oligochaeta	1	24	83		A
MOLLUSCA	*Physa*	3	1	3		
	Potamopyrgus	4	6	21		A
CRUSTACEA	*Paratya*	3	6	21		
EPHEMEROPTERA	*Coloburiscus*	7	1	3		
	Deleatidium	8	8	28	XA	
COLEOPTERA	Elmidae	6	2	7		A
TRICHOPTERA	*Aoteapsyche*	4	19	66		XA
	Costachorema	7	2	7		
	Hydrobiosis	5	3	10		
	Oxyethira	2	10	34		A
DIPTERA	*Aphrophila*	5	8	28		
	Maoridiamesa	3	13	45	A	
	Orthocladiinae	2	29	100	A	VA
	Tanytarsini	3	13	45		A
	Muscidae	3	1	3		
	Austrosimulium	3	1	3		

Prior to the current 2010-2011 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; no 'moderately sensitive' taxa; and three 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and orthoclad midges). Only three of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive' taxon, no 'moderately sensitive' taxa, and two 'tolerant' taxa, whereas no 'highly sensitive', one 'moderately sensitive', and six 'tolerant' taxa comprised the dominant taxa of the summer, 2011 community. Only one of these 9 taxa was dominant in both spring and summer communities (Table 27) and this was reflected in the large 3.8 unit decrease in summer $SQMCI_s$ score (Tables 134 and 135), which was also due to a significant summer decrease in abundance of the 'highly sensitive' mayfly and increase in abundances of two 'tolerant' taxa.

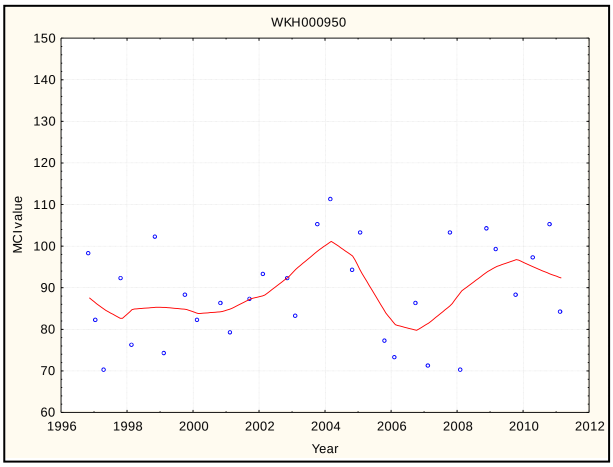
The 'highly sensitive' mayfly (*Deleatidium*) 'and 'tolerant' net-building caddisfly (*Aoteapsyche*) and orthoclad midges have characterised this site's communities on 28%, 66%, and 100% of past survey occasions respectively.

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 (88) is 3 units higher than the altitude prediction and 7 units lower than the distance predictive value. The spring 2010 survey score (105 units) was significantly (Stark, 1998) higher than both predictive values while the summer score (84 units) was lower than both the predictive altitude and distance values. Of the 31 surveys to date at this site, 35% of MCI scores have been less than 85 units while 29% have been greater than 94 units.

3.2.5.4.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 31
Kendall tau = +0.156
p level = 0.218 [>FDR, p = 0.328]
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 nine 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 (21 units) is ecologically significant with more marked variability over the last seven 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 three most recent years.

3.2.5.5 Discussion

Seasonal MCI values typically deteriorated between spring and summer at all four sites by 14, 2, 22, and 21 units respectively in a downstream direction. Seasonal communities shared 57% of the 23 taxa common at the upper site, 52% of 27 taxa at the mid reach site, and in the lower reaches, 35% of 25 taxa at Constance Street and 46% of 28 taxa at the furthest downstream site. There was a decrease in seasonal faunal similarities in a downstream direction as might be anticipated given wider variation in seasonal substrate periphyton coverage and water temperatures in the lower reaches.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 25 units in spring and 42 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 1.5 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 typical of the trend of most past summer seasonal increases in rates of decline.

Between the upper and mid-reach sites, the spring (2.0 units/km) and summer (0.8unit/km) rates of decline were 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 (1.9 unit/km) rates of decline were slightly higher (spring) and much higher (summer) 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 1.5 and 1.1 units per km respectively with an overall average rate of decline of 1.3 MCI units/km over the river's length. Therefore overall rates of decline over the 2010-2011 period were lower in spring and higher in summer than historical rates prior to 2010, but in the upper to mid reaches, spring MCI rate of decline was well above the historical rate.

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 four sites. These included three 'highly sensitive', four 'moderately sensitive', and two 'tolerant' taxa with only the 'highly sensitive' ubiquitous mayfly, *Deleatidium* abundant at all four sites. One of the 'moderately sensitive' taxa was abundant at three sites and one of the 'tolerant' taxa was abundant at three sites (mid and lower reaches of the river). A lower total of 32 taxa was found along the river's length by the summer survey of which seven taxa were present at all four sites. These were very similar to the nine widespread taxa in spring with the loss of two 'highly sensitive' taxa, addition of one 'moderately sensitive' taxon, but no change in 'tolerant' taxa. Only the one 'moderately sensitive' beetle was abundant at all four sites. These dissimilarities in spatial community structure along the length of the Waiwhakaiho River were slightly more pronounced 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 2010-2011 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

Sixteen surveys have been undertaken at this lower reach site in the Mangorei Stream between November 2002 and March 2010. 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 together with spring 2010 and summer 2011

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		March 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGE000970	16	22-33	29	86-113	104	32	104	23	96

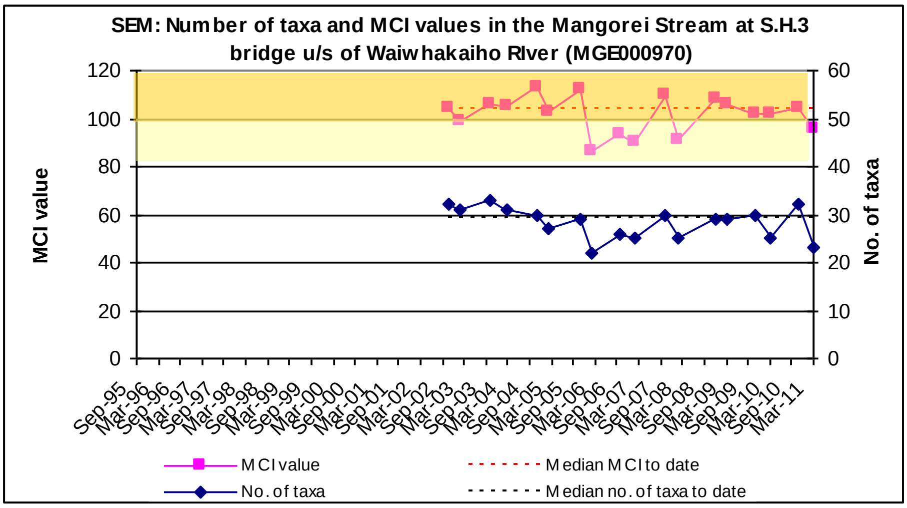


Figure 24 Numbers of taxa and MCI values in the Mangorei Stream at SH3

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 2010-2011 period, spring (32 taxa) richness was higher than this median richness but 9 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 (104 units) has been more typical of mid-reach sites elsewhere on the ringplain, and the spring, 2010 (104 units) and summer, 2011 (96 units) scores were within 8 units of the historical median. These scores categorised this site as having 'good' health generically (Table 1) in spring and 'fair' health in 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 (104 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 2010-2011 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 2010 [16 surveys], and by the spring 2010 and summer 2011

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	2	13		
ANNELIDA	Oligochaeta	1	12	75		A
MOLLUSCA	*Potamopyrgus*	4	3	19		
EPHEMEROPTERA	*Austroclima*	7	8	50	A	A
	Coloburiscus	7	8	50		
	Deleatidium	8	10	63	A	
PLECOPTERA	*Zelandobius*	5	5	31	A	
	Zelandoperla	8	1	6		
COLEOPTERA	Elmidae	6	8	50	A	A
MEGALOPTERA	*Archichauliodes*	7	11	69		A
TRICHOPTERA	*Aoteapsyche*	4	15	94		VA
	Costachorema	7	3	19		
	Hydrobiosis	5	8	50		A
	Neurochorema	6	5	31		
	Confluens	5	3	19		
	Oxyethira	2	5	31		A
	Pycnocentrodes	5	6	38		
DIPTERA	*Aphrophila*	5	12	75	A	
	Maoridiamesa	3	5	31	A	
	Orthocladiinae	2	16	100	VA	VA
	Tanytarsini	3	11	69	A	VA
	Empididae	3	2	13		A
	Muscidae	3	1	6		
	Austrosimulium	3	12	75	A	A

Prior to the current 2010-2011 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*)); six 'moderately sensitive' taxa (mayflies (*Austroclima* and *Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)); and five 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), midges (orthoclads and tanytarsids), and sandfly (*Austrosimulium*)).

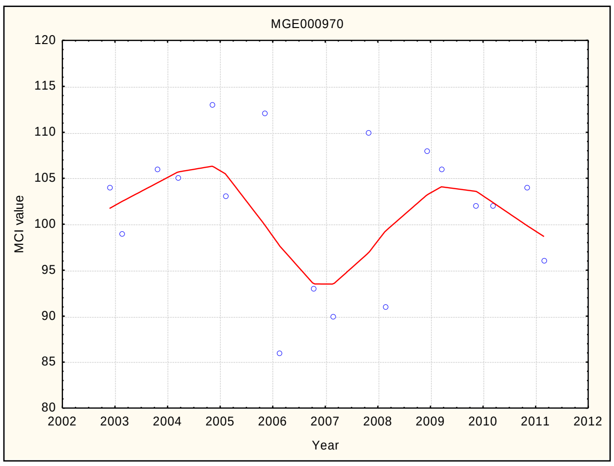
Seven of these predominant taxa were dominant in the spring, 2010 community together with two of the other historically characteristic taxa. The summer, 2011 community was characterised by five of the taxa dominant in spring, together with an additional two 'moderately sensitive' and five 'tolerant' taxa, all of which previously had been characteristic of this site's communities on occasions (Table 29). The one 'highly sensitive' taxon dominant in spring was not dominant in summer and this together with the additional 'tolerant' taxa, was reflected in the 0.6 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 69% 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 (104 units) is 10 units higher than the altitude prediction and 3 units above the distance predictive value. The spring 2010 score (104 units) was higher than these predictive values by 3 to 10 units while the summer 2011 survey score (96 units) was higher by 2 units than the predictive value for altitude, but 5 units lower than the predictive value for distance. Of the 18 surveys to date at this site, 22% of MCI scores have been less than 94 units while 67% have been greater than 101 units.

3.2.6.1.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the nine years (2002-2011) 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 = 18
Kendall tau = -0.132
p level = 0.444 [>FDR, p = 0.536]
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 overall slight decline over the nine 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 and most recently.

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 nine 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 typically decreased between spring and summer (by 8 units) at this lower reach (SH3) site coincident with the percentage composition of 'tolerant' taxa increasing (by 14%) in the summer community. Seasonal communities at this site shared 22 common taxa (67% of the 33 taxa found at this site in 2010-2011), a typical percentage of common taxa considering the difference in 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 (0.6 unit) in summer under warmer, lower flow conditions.

3.2.7 Manganui River

The results found by the 2010-2011 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-two surveys have been undertaken at this mid reach site in the Manganui River between September 1995 and March 2010. 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), together with spring 2010 and summer 2011

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGN000195	32	12-26	21	113-143	126	19	131	17	121

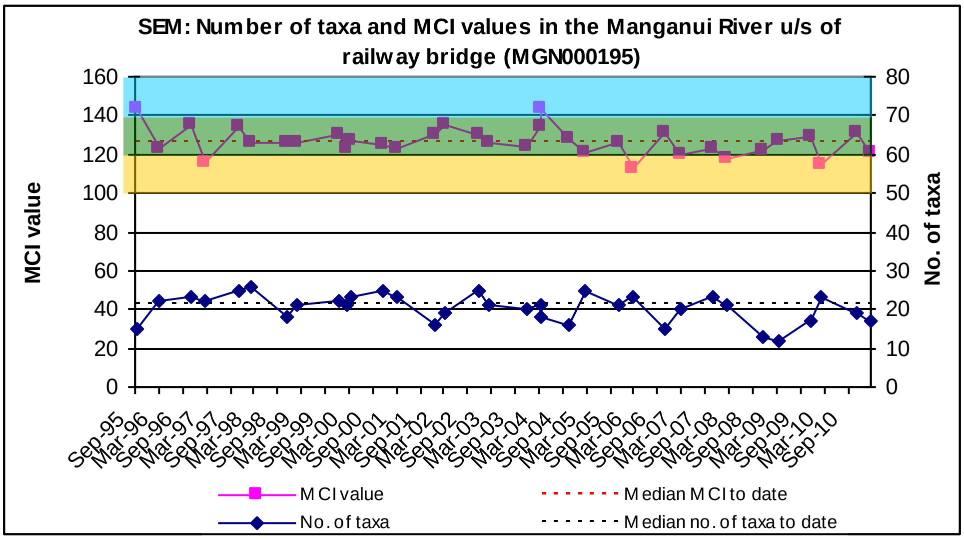


Figure 26 Numbers of taxa and MCI values in the Manganui River above the railway bridge (SH3)

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 2010-2011 period richnesses decreased slightly between spring (19 taxa) and summer (17 taxa) and were up to four taxa lower than 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, 2010 (131 units) and summer, 2011 (121 units) scores were 5 units higher and 5 units lower than the historical median respectively. These scores categorised this site as having 'very good' health generically (Table 1) in spring and summer and, in terms of predictive relationships (Table 2), 'well above expected' health in spring and 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 2010-2011 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 2010 [32 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
EPHEMEROPTERA	*Austroclima*	7	3	9		
	Coloburiscus	7	26	81		
	Deleatidium	8	31	97	VA	VA
	Nesameletus	9	21	66		A
PLECOPTERA	*Acroperla*	5	1	3		
	Megaleptoperla	9	1	3		
	Zelandoperla	8	5	16	A	A
COLEOPTERA	Elmidae	6	29	91	A	VA
MEGALOPTERA	*Archichauliodes*	7	4	13		
TRICHOPTERA	*Aoteapsyche*	4	15	47		
	Hydrobiosis	5	1	3		
	Beraeoptera	8	8	25		
	Pycnocentrodes	5	1	3		
DIPTERA	*Aphrophila*	5	20	63		
	Eriopterini	5	2	6		A
	Austrosimulium	3	1	3		

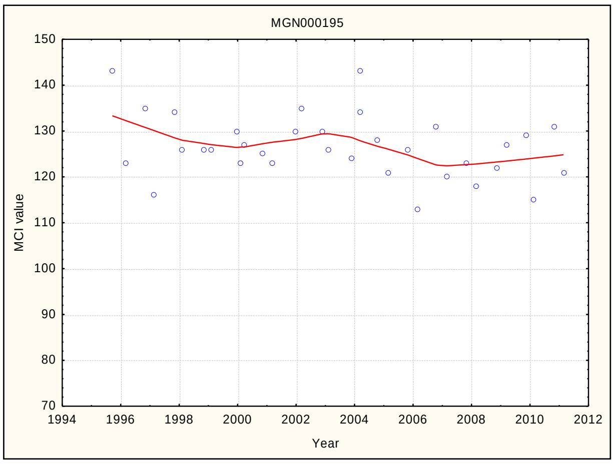
Prior to the current 2010-2011 period, 16 taxa have characterised the community at this site on occasions. These have comprised five 'highly sensitive', nine 'moderately sensitive', and two 'tolerant' taxa i.e. a higher proportion of 'sensitive' taxa than might be expected in the mid-reaches of a ringplain stream. Predominant taxa have included two 'highly sensitive' taxa (mayflies (*Deleatidium* and *Nesameletus*)); and three 'moderately sensitive' taxa (elmid beetles, mayfly (*Coloburiscus*), and cranefly (*Aphrophila*)). Two of these predominant taxa were dominant in the spring, 2010 community together with one of the other historically characteristic taxa. The summer, 2011 community was characterised by the same three taxa dominant in spring, together with two additional taxa (one 'highly sensitive' and one 'moderately sensitive' taxa), which previously had both been characteristic of this site's communities (Table 31). Despite some seasonal differences in dominant taxa composition, both season's SQMCI$_s$ values (7.3 and 6.9 units) were relatively similar (Tables 138 and 139). The two taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 91 % 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, 2010 survey score (131 units) was significantly higher by 13 to 24 units than both predictive values while the summer, 2011 score (121 units) was slightly higher than the predictive altitude value and 14 units higher than the predictive distance value. Of the 34 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 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 34
Kendall tau = -0.197
p level = 0.101 [>FDR, p = 0.176]
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 sixteen year period.

3.2.7.2 Bristol Road site (MGN000427)

3.2.7.2.1 Taxa richness and MCI

Thirty surveys have been undertaken at this lower reach site at Bristol Road in the Manganui river between October 1995 and March 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGN000427	30	15-26	21	77-115	98	17	109	19	97

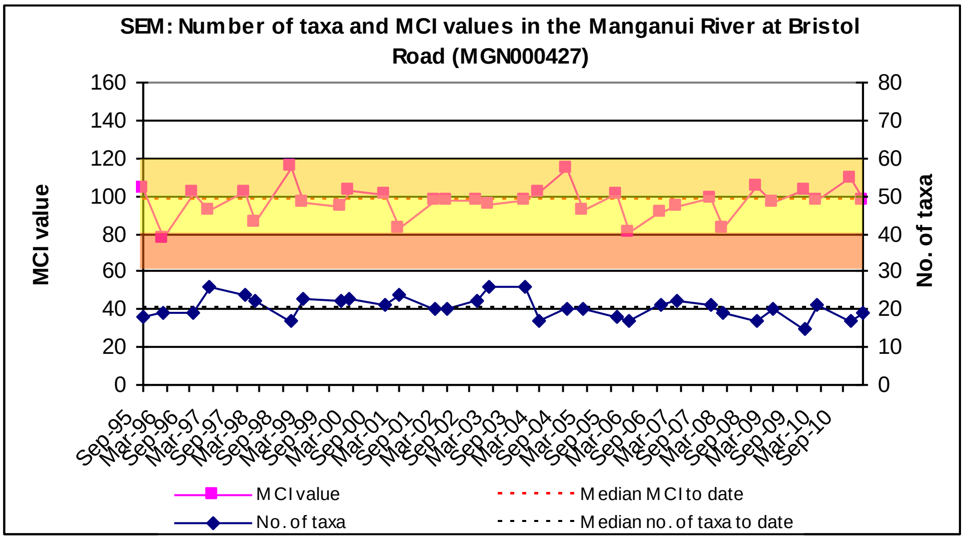


Figure 28 Numbers of taxa and MCI values in the Manganui River at Bristol Road

A moderate range of richnesses (15 to 26 taxa) has been found with a median richness of 21 taxa and representative of typical richnesses in ringplain streams and rivers in the lower reaches. During the 2010-2011 period, spring (17 taxa) and summer (19 taxa) richnesses were relatively similar and slightly less than the historical median richness in both spring and summer, coincident with 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 2010 (109 units) score was significantly higher and the summer (97 units) score was within one unit 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), 'well above expected' (spring) and 'better than expected' (summer) health 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	2	7		
ANNELIDA	Oligochaeta	1	16	53		
EPHEMEROPTERA	*Coloburiscus*	7	5	17	A	
	Deleatidium	8	14	47	XA	XA
COLEOPTERA	Elmidae	6	8	27		A
MEGALOPTERA	*Archichauliodes*	7	2	7		
TRICHOPTERA	*Aoteapsyche*	4	21	70		VA
	Costachorema	7	4	13		
	Hydrobiosis	5	9	30		A
	Neurochorema	6	2	7		
	Oxyethira	2	7	23		
DIPTERA	*Aphrophila*	5	14	47		A
	Maoridiamesa	3	12	40	A	
	Orthocladiinae	2	30	100	XA	VA
	Tanytarsini	3	11	37		
	Empididae	3	2	7		
	Muscidae	3	6	20		
	Austrosimulium	3	7	23		

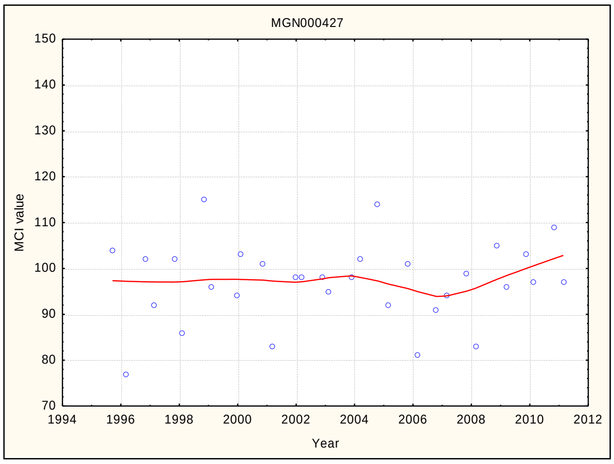
Prior to the current 2010-2011 period 18 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', seven 'moderately sensitive', and ten 'tolerant' taxa i.e. a majority of 'tolerant' taxa but slightly lower than might be expected in the lower reaches of a ringplain river due to this site's elevation above sea level. Predominant taxa have included no 'highly' or 'moderately' sensitive' taxa; and three 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and orthoclads midges). Four of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive', one 'moderately sensitive', and two 'tolerant' taxa, whereas one 'highly sensitive', three 'moderately sensitive', and two 'tolerant' taxa comprised the dominant taxa in the summer, 2011 community. Only two of these eight taxa were dominant in both spring and summer communities (Table 33) which was reflected in the difference of 1.4 units in $SQMCI_s$ scores recorded between 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 47% 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 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.020
p level = 0.869 [>FDR, p = 0.886]
N/S at $p < 0.05$

Figure 29 LOWESS trend plot at the Bristol Road site

The minimal overall positive trend in MCI scores was not statistically significant. Neither was the ecological variability in LOWESS-smoothed scores of 9 units. The smoothed MCI scores were indicative of 'fair' generic river health at this site almost throughout the sixteen year period improving to 'good' very recently. 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 10 units and by a significant (Stark, 1998) 12 units at the lower reach site. The percentage composition of 'tolerant' taxa increased in the summer community by 7% at the mid reach site and 6% at the lower reach site. Seasonal communities at the mid-reach site (SH3) shared 15 common taxa (71% of the 21 taxa found at this site in 2010-2011) compared with 13 shared common taxa (57% of the 23 taxa found in 2010-2011) at the lower reach site (Bristol Road), a more pronounced seasonal change in community structure at the lower-reach site. The two sites shared 12 common taxa (50% of the 24 taxa) in spring and 11 common taxa (44% of 25 taxa) in summer, indicative of the dissimilarity in spatial community structures in spring and more particularly in summer.

MCI score typically fell in a downstream direction in both spring (by 22 units) and in summer (by 24 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 0.75 unit/km in spring increasing slightly to 0.8 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 2010–2011 period were slightly higher in spring and lower in summer than the historical average rate.

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 2010-2011 monitoring year are presented in Table 140 and 141, Appendix I.

3.2.8.1 Derby Road (MKW000200)

3.2.8.1.1 Taxa richness and MCI

Twenty-one surveys have been undertaken at this upper reach site in the Maketawa Stream between March 1998 and February 2010. 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 Derby Road together with spring 2010 and summer 2011

Site code	SEM data (1995 to February 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MKW000200	21	8-33	25	100-141	127	20	129	21	117

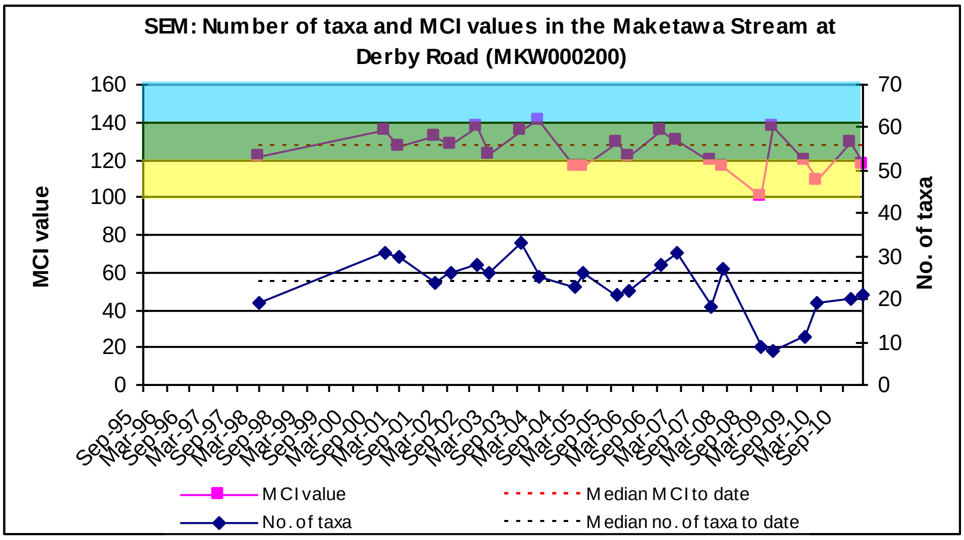


Figure 30 Number of taxa and MCI values in the Maketawa Stream at Derby Road

A very wide range of richnesses (8 to 33 taxa) has been found as a result of the impacts of headwater erosion events, with a median richness of 25 taxa (more representative of typical richnesses in the upper reaches of ringplain streams and rivers). During the 2010-2011 period, spring (20 taxa) and summer (21 taxa) richnesses were very similar and slightly lower than this median richess indicative of recovery from previous erosion events.

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 (127 units) however, has been more typical of upper reach sites elsewhere on the ringplain, with the spring, 2010 (129 units) score relatively similar to the historical median score, but the summer, 2011 (117 units) score 10 units below the historical median. 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), 'expected' and 'worse than expected' health for the upper reaches of a ringplain stream on each of these occasions. The historical median score (127 units) placed this site in the 'very good' and 'expected' categories for the generic and predictive methods of assessment respectively, as a result of the historical impacts of severe headwater erosion events.

3.2.8.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 period are listed in Table 35.

Table 35 Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Maketawa Stream at Derby Road between 1995 and February 2010 [21 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
EPHEMEROPTERA	*Austroclima*	7	1	5		
	Coloburiscus	7	11	52		
	Deleatidium	8	21	100	VA	XA
	Nesameletus	9	11	52	A	VA
PLECOPTERA	*Megaleptoperla*	9	10	48		
	Zelandoperla	8	16	76	A	VA
COLEOPTERA	Elmidae	6	18	86	A	VA
	Hydraenidae	8	3	14		
TRICHOPTERA	*Aoteapsyche*	4	10	48		
	Costachorema	7	5	24		
	Hydrobiosis	5	1	5		
	Beraeoptera	8	10	48	A	
	Helicopsyche	10	8	38		
	Olinga	9	1	5		
	Pycnocentrodes	5	8	38		
DIPTERA	*Aphrophila*	5	10	48		A
	Eriopterini	5	4	19		
	Maoridiamesa	3	4	19		
	Orthocladiinae	2	7	33		

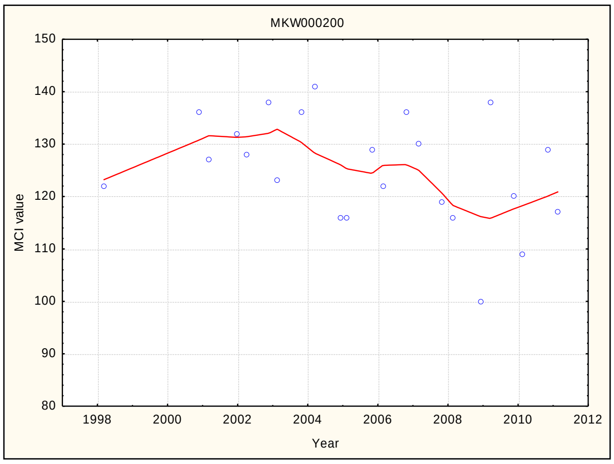
Prior to the current 2010-2011 period, 19 taxa have characterised the community at this site on occasions. These have comprised eight 'highly sensitive', eight 'moderately sensitive', and three 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the upper reaches of a ringplain stream. Predominant taxa have included three 'highly sensitive' taxa (mayflies (*Deleatidium*) on every occasion, and *Nesameletus*) and stonefly (*Zelandoperla*)); two 'moderately sensitive' taxa (mayfly (*Coloburiscus* and elmid beetles); but no 'tolerant' taxa. Four of these predominant taxa and one other 'highly sensitive' taxon were dominant in the spring, 2010 community while the summer, 2011 community was characterised by four 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 35). The similarity in the seasonally most dominant taxa composition was evident in the very similar $SQMCI_s$ scores (Tables 140 and 141). The taxa recorded as very or extrememly abundant during spring and/or summer had characterised this site's communities on 52% to 100% of past survey occasions.

3.2.8.1.3 Predicted stream 'health'

The Maketawa Stream site at Derby Road is 2.3 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and 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 (128 units) is 5 units higher than the altitude prediction and 7 units above the distance predictive value. The spring, 2010 survey score (129 units) was up to 8 units higher than the predictive values while the summer, 2011 score (117 units) was slightly lower (by 4 to 6 units) than both predictive values. Of the 23 surveys to date at this site, 30% 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 2011 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 Maketawa Stream at Derby 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 = 23
Kendall tau = -0.250
p level = 0.095 [>FDR, p = 0.173]
N/S at $p < 0.05$

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

No significant temporal trend in MCI scores has been found over the eleven year monitoring period at this relatively pristine site where scores have tended to decrease gradually, particularly since the more recent headwater erosion events. The variability in LOWESS-smoothed scores (range of 17 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 'expected' almost throughout the eleven year period, but falling to 'worse than 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

Twenty surveys have been undertaken at this mid-reach site at Tarata Road in the Maketawa Stream between March 1998 and February 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MKW000300	20	12-31	23	90-115	100	21	115	24	107

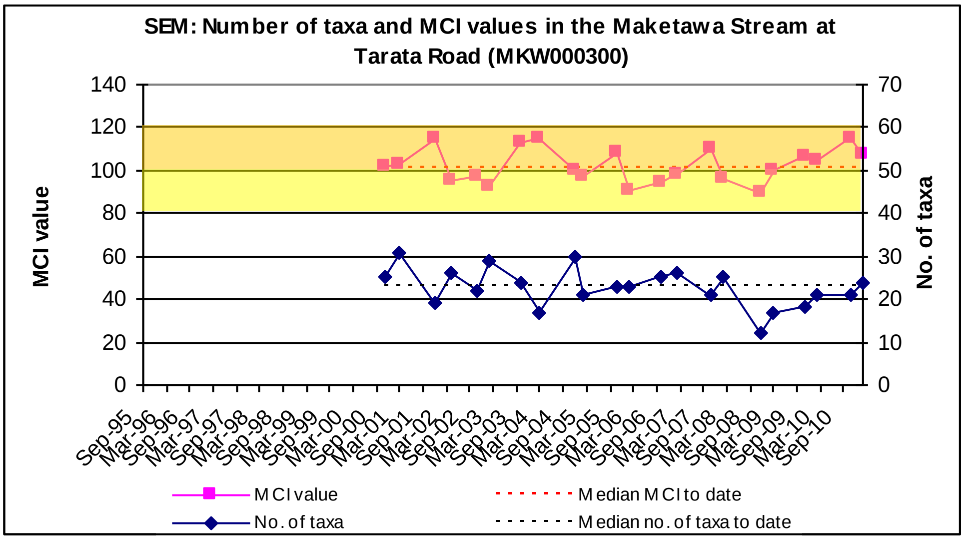


Figure 32 Number of taxa and MCI values in the Maketawa Stream at Tarata Road

A wide range of richnesses (12 to 31 taxa) has been found; wider than might be expected, with a median richness of 23 taxa which is more representative of typical richnesses in the mid-reaches of ringplain streams and rivers. During the 2010-2011 period, spring (21 taxa) and summer (24 taxa) richnesses were relatively similar and within two taxa of the median taxa number on both occasions coincident with patchy to widespread 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 (100 units) has been relatively typical of mid-reach sites elsewhere on the ringplain. The spring, 2010 (115 units) and summer, 2011 (107 units) scores were within the range typical for such a site and higher than the historical median by a significant (Stark, 1998) 15 units in spring, and by 7 units in summer. 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 (100 units) placed this site in the 'good' 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 2010-2011 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 2010 [20 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	7	35		
EPHEMEROPTERA	*Austroclima*	7	3	15		
	Coloburiscus	7	9	45	A	A
	Deleatidium	8	11	55	XA	XA
	Nesameletus	9	0			A
PLECOPTERA	*Acroperla*	5	1	5		
COLEOPTERA	Elmidae	6	4	20		VA
MEGALOPTERA	*Archichauliodes*	7	2	10		
TRICHOPTERA	*Aoteapsyche*	4	11	55		VA
	Costachorema	7	8	40		A
	Hydrobiosis	5	7	35		A
	Neurochorema	6	3	15		
	Beraeoptera	8	2	10		
	Confluens	5	2	10		
	Oxyethira	2	4	20		
	Pycnocentrodes	5	1	5		
DIPTERA	*Aphrophila*	5	17	85	A	VA
	Maoridiamesa	3	14	70		A
	Orthocladiinae	2	20	100	VA	A
	Tanytarsini	3	7	35		
	Empididae	3	1	5		
	Muscidae	3	4	20		
	Austrosimulium	3	2	10		

Prior to the current 2010-2011 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 slight predominance of 'sensitive' taxa as might be expected in the mid-reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); one 'moderately sensitive' taxon (cranefly (*Aphrophila*)); and three 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*) and midges (orthoclads and *Maoridiamesa*)). Four of the historically characteristic taxa were dominant in the spring 2010 community.

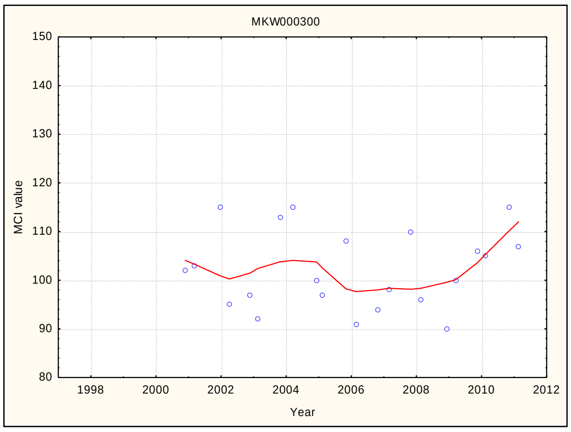
These comprised one 'highly sensitive', two 'moderately sensitive', and one 'tolerant' taxa, whereas these same taxa, plus one 'highly sensitive' (not previously a characteristic taxon), three 'moderately sensitive', and two 'tolerant' taxa comprised the dominant taxa in the summer community. Only four of these 10 taxa were dominant in both spring and summer communities (Table 37). Despite these seasonal dominance differences, there was a minimal (0.1 unit) decrease in the summer $SQMCI_S$ score (Tables 140 and 141). The taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 20% to 100% of past survey occasions.

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 (101 units) is only one unit above the altitude prediction and equivalent to the predictive distance value, while the spring, 2010 survey score (115 units) was significantlyhigher than these predictive values. The summer, 2011 score (107 units) was also higher (but not significantly) than these predictive values. Of the 22 surveys to date at this site, 41% of MCI scores have been less than 100 units while 50% have been greater than 101 units.

3.2.8.2.4 Temporal trends in 1995 to 2011 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 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 = 22
Kendall tau = +0.044
p level = 0.776 [>FDR, p = 0.817]
N/S at $p < 0.05$

Figure 33 LOWESS trend plot at the Tarata Road site

The slightly increasing trend in MCI scores found over the eleven year monitoring period has not been statistically significant. Ecological variability in LOWESS-smoothed scores (which ranged over 14 units) has been marginally significant ecologically 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 (Derby Road) site (by 12 units) and atypically to a slightly lesser degree (by 8 units) at the mid-reach site. Seasonal communities at the upper reach site shared 14 common taxa (52% of the 27 taxa found at this site in 2010-2011) compared with 16 shared common taxa (55% of the 29 taxa found in 2010-2011) at the mid-reaches site (Tarata Road); similar seasonal changes in community structures at both of the sites. The two sites shared 14 common taxa (52% of the 27 taxa) in spring and 16 common taxa (55% of 29 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and summer, although atypically slightly less so in summer.

MCI scores typically fell in a downstream direction in both spring (by 14 units) and atypically, less markedly in summer (by 10 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 0.7 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 (i.e. slightly above the predicted rate). Therefore rates of decline over the 2010–2011 period were lower in both seasons than the long terms average rate prior to 2011.

3.2.9 Waitara River

The results found by the 2010-2011 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

Thirty surveys have been undertaken at this lower reach site in the Waitara River between November 1995 and March 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WTR000850	30	9-32	21	64-101	86	15	91	15	77

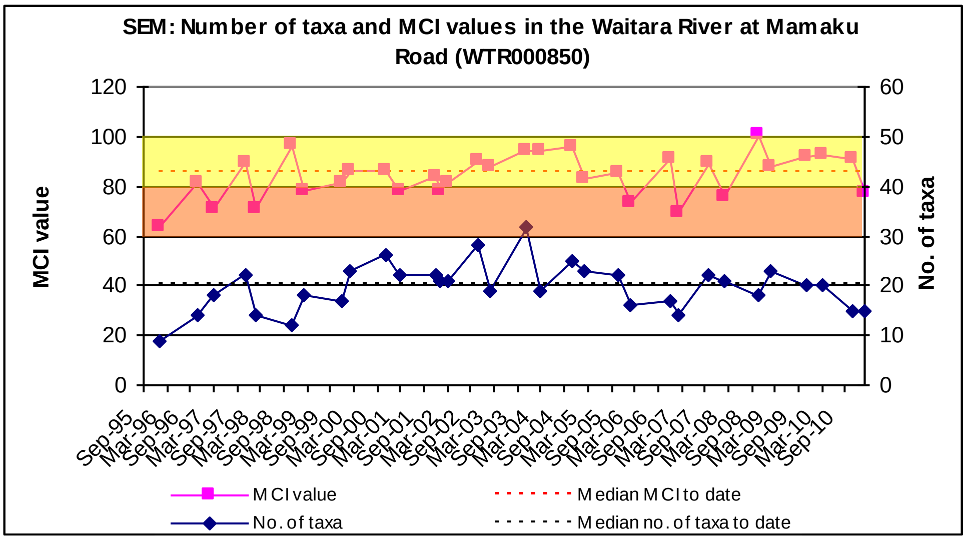


Figure 34 Numbers of taxa and MCI values in the Waitara River upstream of Methanex at Mamaku Road

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 2010-2011 period, spring and summer richnesses (15 taxa) were six taxa fewer than this median richness.

MCI values have had a wide range (37 units) at this site, and typical of a site in the lower reaches of streams and rivers. However, the historical median value (86 units) has been more typical of lower reach sites elsewhere. The spring, 2010 (91 units) and summer, 2011 (77 units) scores were 5 units higher and 9 units lower respectively than the historical median. These scores categorised this site as having 'fair' health generically (Table 1) in spring and 'poor' health in summer and, in terms of predictive relationships (Table 2), 'better than expected' (spring) and 'expected' (summer) health for the lower reaches of a river with some ringplain catchment component on 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.

3.2.9.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 March 2010 [30 surveys], and by the spring 2010 and summer 2011

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	2	7		
ANNELIDA	Oligochaeta	1	20	67		A
	Branchyura	1	1	3		
	Polychaeta	3	2	7		
MOLLUSCA	*Latia*	5	10	33		
	Potamopyrgus	4	17	57		
CRUSTACEA	Tanaidacea	3	1	3		
	Paratya	3	13	43		
EPHEMEROPTERA	*Deleatidium*	8	7	23	VA	A
COLEOPTERA	Elmidae	6	1	3		
TRICHOPTERA	*Aoteapsyche*	4	18	60		
	Oxyethira	2	10	33		
	Pycnocentrodes	5	4	13		
DIPTERA	*Aphrophila*	5	11	37		
	Maoridiamesa	3	3	10		
	Orthocladiinae	2	20	67	A	VA
	Tanytarsini	3	9	30		
	Austrosimulium	3	1	3		

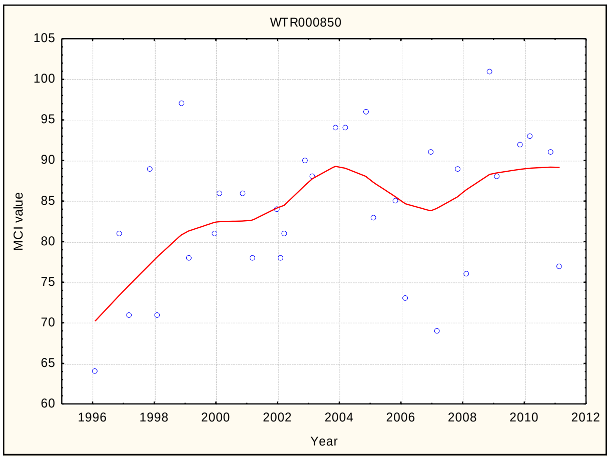
Prior to the current 2010-2011 period, 18 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', four 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included only four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and orthoclad midges). Only one of these predominant taxa was dominant in the spring, 2010 community together with one of the other historically characteristic taxa. The summer, 2011 community was characterised by one additional taxon ('tolerant' oligochaete worms) to those dominant in spring; all of which previously had been characteristic of this site's communities (Table 39). Despite very few seasonal differences in characteristic taxa, the decrease in numbers of the 'highly sensitive' mayfly taxon and an increase in abundances within two 'tolerant' taxa in the summer survey was reflected in the significant difference in $SQMCI_s$ scores (Tables 142 and 143) with a decrease of 3.6 $SQMCI_s$ units in summer. The two taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 23% to 67% of the past survey occasions.

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, 2010 (91 units) score was higher than this predictive value by 6 units and the summer, 2011 score (77 units) was lower by 9 units than the predictive value. These two 2010-2011 surveys' scores were also 16 and 2 units higher than the median MCI (75 units) found from 210 previous surveys of 'control' sites below 25 m asl in hill country catchment streams and rivers (TRC, 1999 (updated, 2011)). Of the 32 surveys to date at this river site, 16% of MCI scores have been less than 75 units while 44% have been greater than 86 units.

3.2.9.3 Temporal trends in 1995 to 2011 data

Non-paramentric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen years (1995-2011) 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 = 32
Kendall tau = +0.249
p level = 0.045 [>FDR, p = 0.102]
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 sixteen year period which has not been significant statistically (P >0.10 after FDR). 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 (19 units) has been ecologically significant over 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 sixteen year period.

3.2.9.4 Discussion

Seasonal MCI values typically decreased between spring and summer at this lower reach site with the percentage community compositions of 'tolerant' taxa increasing by 20% in summer. Seasonal communities at this site shared only 8 common taxa (36% of the 22 taxa found at this site in 2010-2011), a low percentage of common taxa and reflected in the significantly different MCI values for the seasonal surveys. A decrease in the abundance of the 'highly sensitive' mayfly taxon and increase in abundances of two 'very tolerant' of two individual 'tolerant' taxa in particular, accounted for the significant decrease in $SQMCI_s$ value (3.6 units) in summer, although algal substrate cover was patchy to widespread on both occasions.

3.2.10 Mangati Stream

The results found by the 2010-2011 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

Thirty-one 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 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Mar 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGT000488	31	9-29	17	56-85	77	9	69	15	79

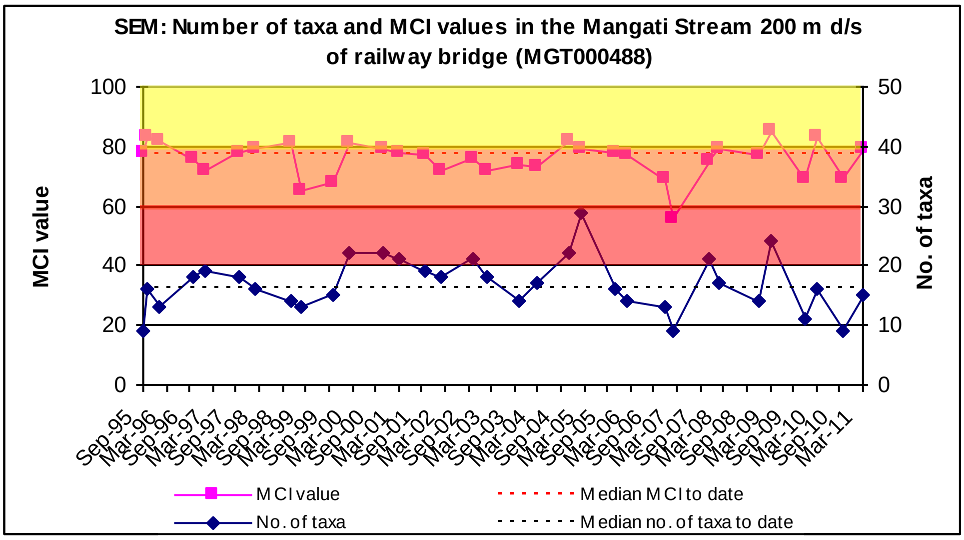


Figure 36 Numbers of taxa and MCI values in the Mangati Stream downstream of the railbridge

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 2011)). During the 2010-2011 period, spring (9 taxa) and summer (15 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, 2010 (69 units) and summer, 2011 (79 units) scores, although relatively different, were within 8 units of the historical median. These scores were also 2 units (spring) and a significant 12 units (summer) higher than the median score previously recorded by 39 surveys at 'control' sites in lowland coastal streams at altitudes between 25 m and 50 m asl

(TRC, 1999 (updated, 2011)). These scores categorised this site as having 'poor' health generically (Table 1) in spring and 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 2010-2011 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 2010 [31 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
PLATYHELMINTHES	*Cura*	3	5	16		
NEMERTEA	Nemertea	3	3	10		
ANNELIDA	Oligochaeta	1	29	94	A	A
	Lumbricidae	5	1	3		
MOLLUSCA	*Physa*	3	4	13		
	Potamopyrgus	4	31	100	A	VA
	Sphaeriidae	3	1	3		
CRUSTACEA	Ostracoda	1	9	29		
	Paracalliope	5	28	90		A
	Phreatogammarus	5	1	3		
EPHEMEROPTERA	*Austroclima*	7	11	35		
	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	14	45	VA	
	Austrosimulium	3	19	61		

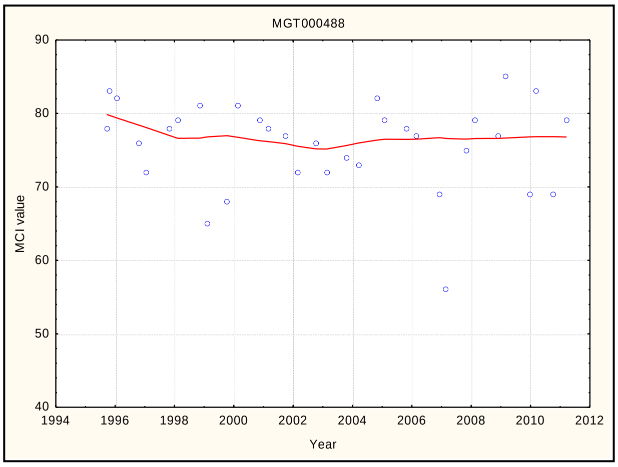
Prior to the current 2010-2011 period, 18 taxa have characterised the community at this site on occasions. These have comprised seven 'moderately sensitive' and eleven 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa as would be expected in the swampier upper reach of a softer bottom, macrophyte dominated, small coastal stream. Predominant taxa have included only one 'moderately sensitive' taxon (amphipod (*Paracalliope*) and three 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), and sandfly (*Austrosimulium*)). Only three of the characteristic taxa were dominant in the spring, 2010 community and again in the summer, 2011 community which was characterised by two of the taxa dominant in spring, together with an additional single 'moderately sensitive' taxon, all of which had been characteristic of this site's communities in the past (Table 41). The decrease in abuncance of 'very tolerant' midges and increase in abundance of 'moderately sensitive' amphipods in summer was reflected in the increase (of 1.5 units) between spring and summer $SQMCI_s$ scores (Tables 144 and 145). The two taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 45% to 100% of past surveys.

3.2.10.1.3 Predicted 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.

3.2.10.1.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 33
Kendall tau = - 0.092
p level = 0.454 [>FDR, p = 0.536]
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 no recent change in the trend. 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. 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)

3.2.10.2.1 Taxa richness and MCI

Thirty-one surveys have been undertaken at this lower reach site at SH45 in the Mangati Stream between October 1995 and March 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Mar 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGT000520	31	3-22	10	44-76	63	5	52	10	70

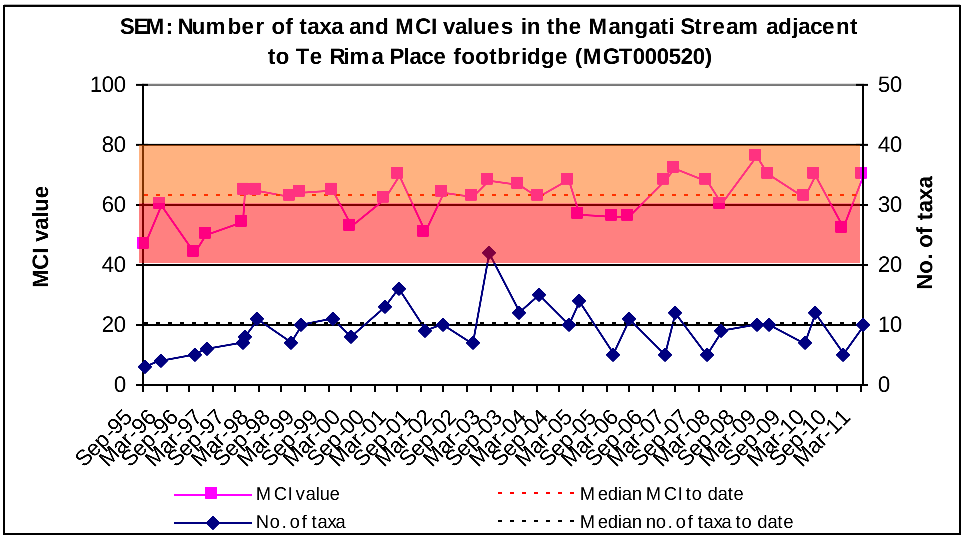


Figure 38 Numbers of taxa and MCI values in the Mangati Stream at Te Rima Place footbridge

A wide range of richnesses (3 to 22 taxa) has been found; wider than might be expected with a median richness of 10 taxa but not atypical of richnesses in the lower reaches of small coastal streams. During the 2010-2011 period, spring (5 taxa) and summer (10 taxa) richnesses were dissimilar but within 5 taxa of the median taxa number. The lower richness in spring was coincident with additional 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, 2010 (52 units) and summer, 2011 (70 units) scores within the range typical for such a site with the spring score a significant 11 units lower than the historical median. These scores were a significant 23 units (spring), and 5 units (summer) lower than the median score found by 217 surveys at 'control sites' in similar lowland coastal streams at altitudes of less than 25 m asl (TRC, 1999 (updated, 2011)). These scores categorised this site as having 'very poor' (spring) and 'poor' (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 2010-2011 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 2010 [31 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	2	6		
ANNELIDA	Oligochaeta	1	31	100	VA	XA
MOLLUSCA	*Potamopyrgus*	4	13	42	VA	XA
CRUSTACEA	Ostracoda	1	1	3		
TRICHOPTERA	*Oxyethira*	2	1	3		
	Triplectides	5	3	10		
DIPTERA	Orthocladiinae	2	24	77	A	
	Empididae	3	2	6		
	Austrosimulium	3	5	16		

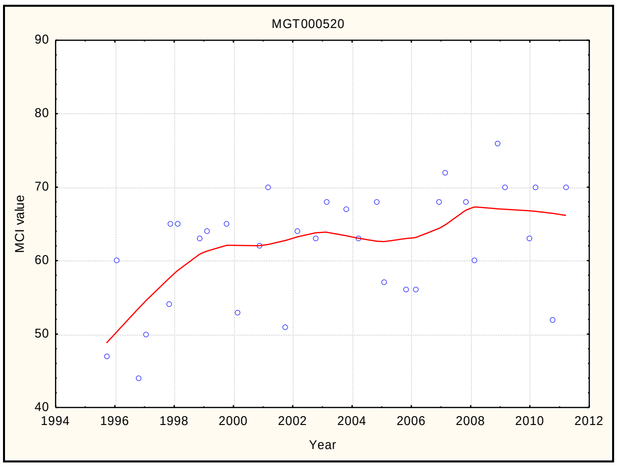
Prior to the current 2010-2011 period a small number of taxa (9) has characterised the community at this site on occasions. These have comprised one 'moderately sensitive' and eight 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a small coastal ringplain stream. Predominant taxa have included no 'moderately sensitive' taxa but two 'tolerant' taxa (oligochaete worms and orthoclad midges). Only three of the historically characteristic taxa were dominant in the spring, 2010 community. These were all 'tolerant' taxa whereas only two (most abundant) of these 'tolerant' taxon comprised the dominant taxa in the summer community and their significant abundances on both occasions were reflected in the identical seasonal $SQMCI_s$ scores (Tables 144 and 145). Two of these three taxa were dominant in both spring and summer communities (Table 43). The two taxa recorded as very and/or extremely abundant during spring and summer had characterised this site's communities on 42% 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 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 33
Kendall tau = + 0.349
p level = 0.0043 [>FDR, p = 0.020]
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 although this improvement has plateaued in recent years. The LOWESS-smoothed range of scores (19 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 six common taxa (33% of the 18 taxa found at this site in 2010-2011) compared with only three shared common taxa (25% of the 12 taxa found in 2010-2011) at the lower reaches site, a more pronounced seasonal change in community structure at the lower reach site. The two sites shared four common taxa (40% of the 10 taxa) in spring and seven common taxa (39% of 18 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 17 units) and less markedly in summer (by 9 units), over a stream distance of 1.4 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), but typical of a small coastal developed catchment stream.

Using the long-term median SEM MCI scores for both sites (Appendix II), the overall rate of decline has been 10 MCI units/km over the surveyed length of the stream. Therefore rates of decline over the 2010-2011 period were higher in spring (12.1 units/km) and lower in summer (6.4 units/km) than this historical average rate.

3.2.11 Waimoku Stream

The results found by the 2010-2011 surveys are presented in Table 146 and Table 147, Appendix I.

3.2.11.1 Lucy's Gully (WMK000100)

3.2.11.1.1 Taxa richness and MCI

Twenty-two surveys have been undertaken at this upper reach site in the Waimoku Stream (in the Kaitake Ranges) between December 1999 and February 2010. 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, together with spring 2010 and summer 2011

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WMK000100	22	25-37	31	121-137	131	22	139	32	130

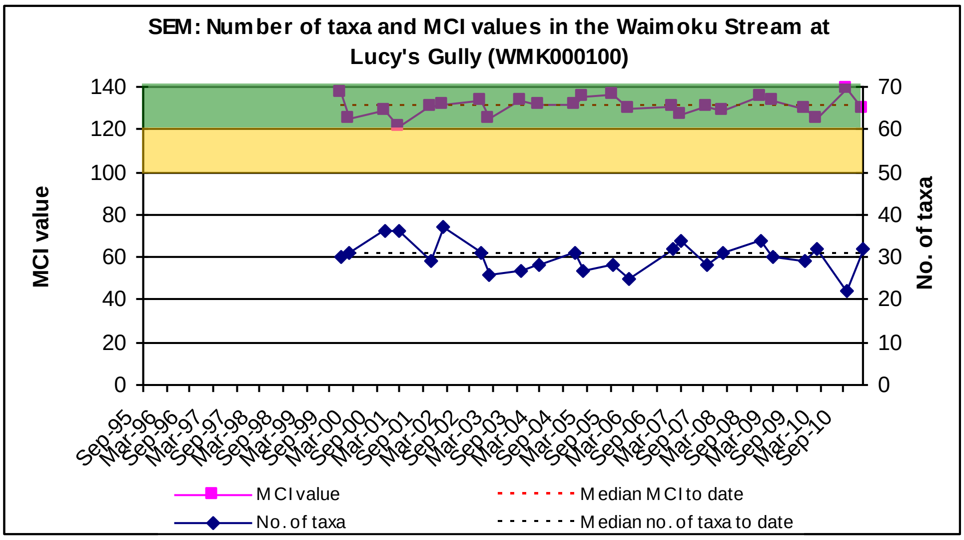


Figure 40 Numbers of taxa and MCI values in the Waimoki Stream at Lucy's Gully

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 2010-2011 period, spring (22 taxa) and summer (32 taxa) richnesses were quite different, lower than (spring) and very close to (summer) 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 (131 units) also has been typical of upper reach sites elsewhere on the ringplain, and the spring, 2010 (139 units) and summer, 2011 (130 units) scores were eight units above and one unit 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), 'better than expected' and 'expected' health for the upper reaches of a ringplain stream on spring and summer occasions respectively. The historical median score (131 units) placed this site in the 'very good' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.11.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 February 2010 [22 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	3	14		
MOLLUSCA	*Potamopyrgus*	4	5	23		
EPHEMEROPTERA	*Austroclima*	7	16	73	VA	A
	Coloburiscus	7	22	100	VA	VA
	Deleatidium	8	20	91	VA	VA
	Ichthybotus	8	1	5		
	Zephlebia group	7	19	86		A
PLECOPTERA	*Austroperla*	9	16	73		A
	Stenoperla	10	2	9		
	Zelandobius	5	1	5		
COLEOPTERA	Elmidae	6	1	5		
	Ptilodactylidae	8	4	18	A	
MEGALOPTERA	*Archichauliodes*	7	2	9	A	
TRICHOPTERA	*Hydrobiosella*	9	7	32		
	Orthopsyche	9	22	100	VA	VA
DIPTERA	Orthocladiinae	2	18	82	A	
	Polypedilum	3	4	18		

Prior to the current 2010-2011 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 three 'highly sensitive' taxa (mayfly (*Deleatidium*), stonefly (*Austroperla*), and free-living caddisfly (*Orthopsyche*)); three 'moderately sensitive' taxa (mayflies (*Austroclima, Coloburiscus,* and *Zephlebia* group)); and one 'tolerant' taxon (orthoclad midges). Five of these predominant taxa were characteristic of the spring, 2010 community together with two of the other historically characteristic taxa. The summer, 2010 community was characterised by four of the taxa dominant in spring, all of which previously had been predominantly characteristic of this site's communities (Table 45). All taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 73% to 100% of past surveys.

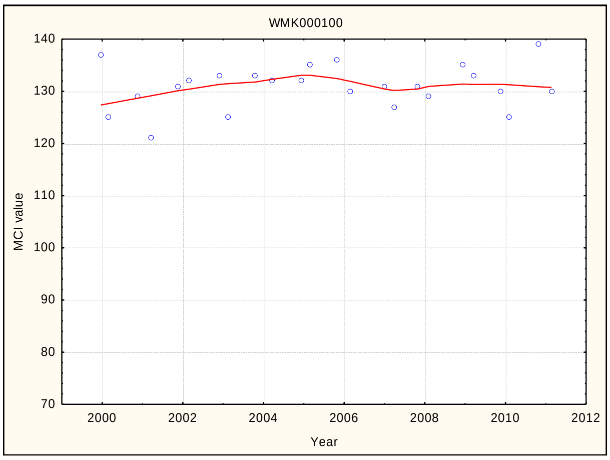
3.2.11.1.3 Predicted stream 'health'

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 (131 units) is significantly 30 units higher than the altitude prediction and within one unit of the distance predictive value. The spring, 2010 survey score (139 units) was 7 units above the distance predictive value while the summer score (130 units) was very similar to the distance predictive value. Of the 24 surveys to date at this site, no MCI scores have been less than 101 units while 33% have been greater than 132 units.

3.2.11.1.4 Temporal trends in 1995 to 2011 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 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 = 24
Kendall tau = +0.056
p level = 0.700 [>FDR, p = 0.759]
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 twelve 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' throughout the twelve year period.

3.2.11.2 Oakura Beach (WMK000298)

3.2.11.2.1 Taxa richness and MCI

Twenty-two surveys have been undertaken at this lower reach site at Oakura Beach in the Waimoku Stream between December 1999 and February 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WMK000298	22	10-26	20	75-101	89	21	101	25	86

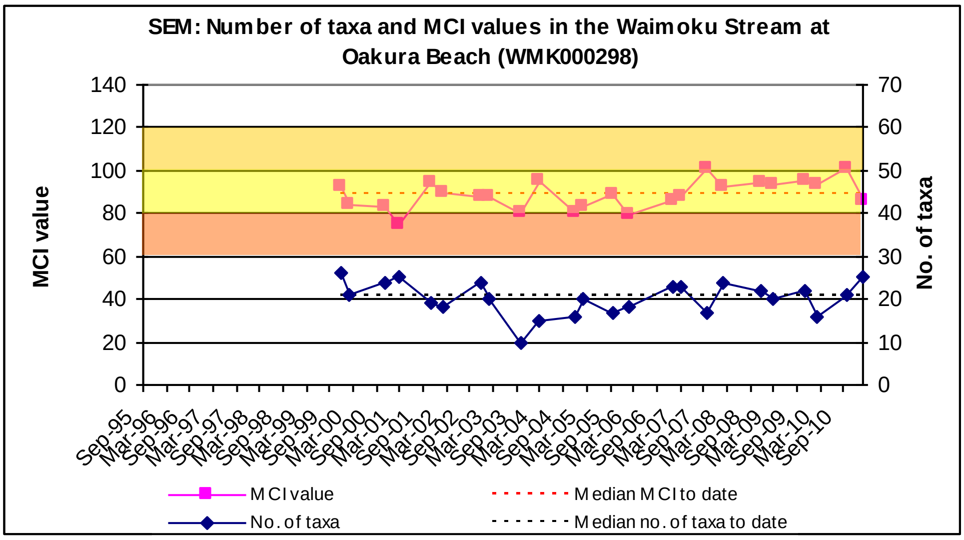


Figure 42 Numbers of taxa and MCI values in the Waimoku Stream at Oakura Beach

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 2010-2011 period, spring (21 taxa) and summer (25 taxa) richnesses were different by five taxa; similar to the median taxa number in spring but higher than the median richness in summer, coincident with upstream channel disturbance and bank reconstruction works prior to the spring survey.

MCI scores have had a relatively wide range (26 units) at this site, typical of sites in the lower reaches of ringplain streams. The historical median value (89 units) has been relatively typical of lower reach sites elsewhere on the ringplain. The spring, 2010 (101 units) and summer, 2010 (86 units) scores were within the range typical for such a site and significantly higher than the historical median by 12 units in spring (when the score was equal with the previous maximum score) and 3 units lower than the historical median in summer. 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 lower reaches of a ringplain stream. The historical median score (89 units) placed this site in the 'fair' category for generic and 'expected' category for predictive methods of assessment.

3.2.11.2.2 Commnity composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 February 2010 [22 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	3	14		
ANNELIDA	Oligochaeta	1	19	86		A
MOLLUSCA	*Potamopyrgus*	4	16	73		VA
	Sphaeriidae	3	1	5		
CRUSTACEA	Ostracoda	1	1	5		
	Paratya	3	1	5		
EPHEMEROPTERA	*Austroclima*	7	5	23		
	Coloburiscus	7	1	5	A	A
	Deleatidium	8	0	0	A	
	Zephlebia group	7	0	0		A
TRICHOPTERA	*Hydrobiosis*	5	3	14		A
	Oxyethira	2	3	14		
	Triplectides	5	4	18		
DIPTERA	*Aphrophila*	5	5	23		A
	Maoridiamesa	3	1	5		
	Orthocladiinae	2	21	95	VA	A
	Polypedilum	3	2	9		VA
	Empididae	3	1	5		
	Austrosimulium	3	10	45	A	A

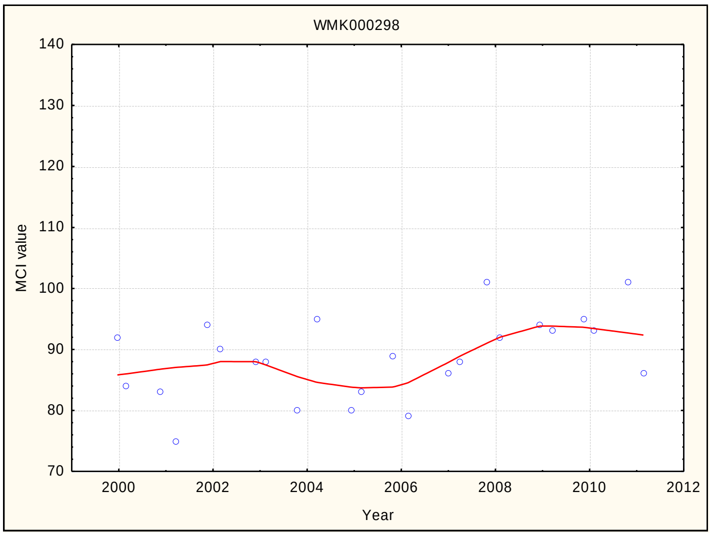
Prior to the current 2010-2011 period 17 taxa have characterised the community at this site on occasions. These have comprised no 'highly sensitive', five 'moderately sensitive', and twelve 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'moderately sensitive' taxa, but three 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges). Only three of the historically characteristic taxa were dominant in the spring 2010, community together with one additional taxon ('highly sensitive' mayfly) not previously characteristic of this site. These were comprised of the one 'highly sensitive', one 'moderately sensitive' and two 'tolerant' taxa, while an additional three 'moderately sensitive' and three 'tolerant' taxa (but no 'highly sensitive' taxa) comprised the dominant taxa in the summer community. Three of these 10 taxa were dominant in both spring and summer communities (Table 47). The three taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 9% to 95% of past surveys.

3.2.11.2.3 Predicted stream 'health'

The Waimoku 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 (89 units) is slightly higher (by 4 units) than the altitude prediction but 27 units lower than the predictive distance value, while the spring, 2010 survey score (101 units) and summer, 2011 score (86 units) were higher than the predictive altitude value by 16 and 1 units respectively. Of the 24 surveys to date at this site, 29% 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 2011 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 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 = 24
Kendall tau = +0.285
p level = 0.051 [>FDR, p = 0.111]
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 twelve 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 were insignificantly lower (by 9 units) in summer as is typical at the upper reach Lucy's Gully site whereas a more typical, significant (Stark, 1998) seasonal decrease (of 15 units) was found at the lower reach site where the percentage composition of 'tolerant' taxa increased by 14% in the summer community. Seasonal communities at the upper reach site shared 19 common taxa (54% of the 35 taxa found in 2010-2011) compared with 15 shared common taxa (48% of the 31 taxa found in 2010-2011) 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 11 common taxa (34% of the 32 taxa) in spring and 12 common taxa (27% of 45 taxa) in summer, indicative of the dissimilarity in spatial community structures in spring and to a greater extent in summer.

MCI score typically fell in a downstream direction in both spring (by 38 units) and slightly more markedly in summer (by 44 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 9.5 units/km in spring increasing to 11.0 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 2010–2011 period were lower in spring and slightly higher in summer than the average rate prior to 2011.

3.2.12 Waiau Stream

The results found by the 2010-2011 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 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1998 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WAI000100	23	17-30	21	80-98	88	21	93	30	99

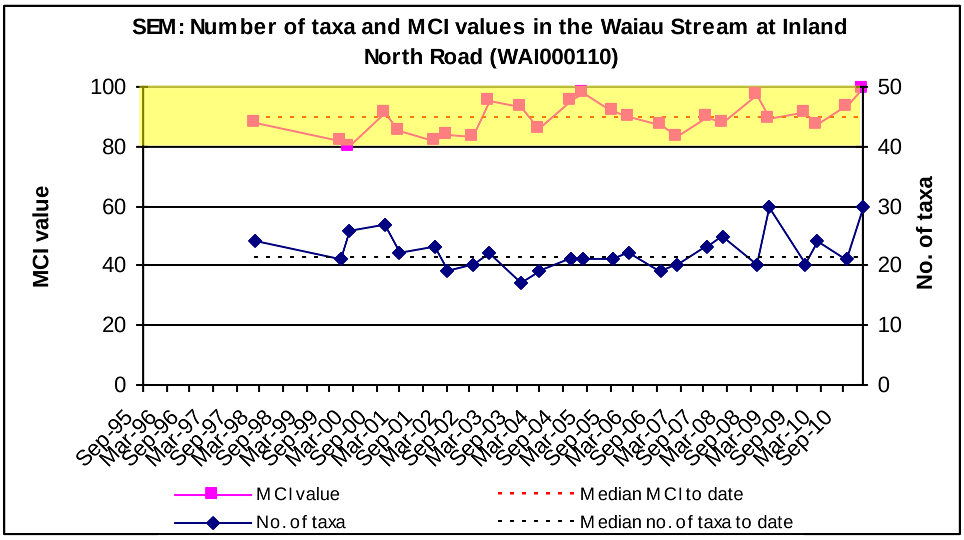


Figure 44 Numbers of taxa and MCI values in the Waiau Stream at the Inland North Road site

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 not on the ringplain where a median richness of 20 taxa has been recorded from 89 previous surveys of 'control' sites at similar altitudes (TRC, 1999 (updated, 2011)). During the 2010-2011 period, spring (21 taxa) and summer (30 taxa) richnesses were relatively different. They were well above the median in summer and equivalent to this median richness in spring.

MCI values have had a moderate range (18 units) at this site. The median value (88 units) is typical of lower reach sites in ringplain streams and rivers however, and the spring, 2010 (93 units) and summer, 2011 (9 units) scores were higher than typical for such a site. The summer score as one unit higher than the historical maximum MCI score for this site coincident with the equal highest taxa richness to date. These scores varied from 5 to a significant 11 units higher than the historical median in spring and summer respectively and categorised this site as having 'fair' (spring and summer) health generically (Table 1) and were significantly higher (Stark, 1998) than the median MCI score (77 units) recorded by 89 previous surveys of 'control' sites between 50 and 79 m asl in small, lowland streams in Taranaki (TRC, 1999 (updated, 2011)). 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 2010-2011 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 2010 [23 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	3	13		
ANNELIDA	Oligochaeta	1	14	61	A	A
MOLLUSCA	*Latia*	5	9	39		A
	Potamopyrgus	4	23	100	A	VA
CRUSTACEA	*Paracalliope*	5	15	65		
EPHEMEROPTERA	*Austroclima*	7	20	87	VA	VA
PLECOPTERA	*Zelandobius*	5	0	0	A	
COLEOPTERA	Elmidae	6	23	100	VA	VA
TRICHOPTERA	*Aoteapsyche*	4	21	91	A	VA
	Hydrobiosis	5	8	35		
	Hudsonema	6	2	9		
	Oxyethira	2	7	30		
	Pycnocentria	7	9	39	A	
	Pycnocentrodes	5	18	78	VA	VA
DIPTERA	*Aphrophila*	5	12	52	A	A
	Maoridiamesa	3	1	4		
	Orthocladiinae	2	19	83		A
	Polypedilum	3	1	4		
	Tanytarsini	3	1	4		
	Austrosimulium	3	5	22		
ACARINA	Acarina	5	1	4		

Prior to the current 2010-2011 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 mid reaches of a lowland stream beyond the ringplain.

Predominant taxa have included five 'moderately sensitive' taxa (amphipod (*Paracalliope*), mayfly (*Austroclima*), elmid beetles, stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)) and four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisly (*Aoteapsyche*), and orthoclad midges).

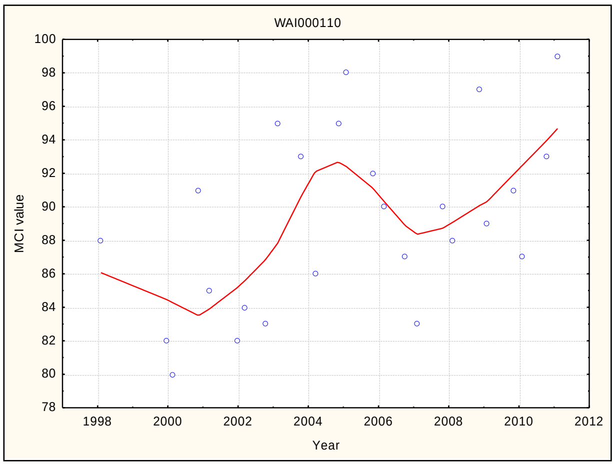
Eight of the historically characteristic taxa and an additional 'moderately sensitive' taxon (stonefly) were dominant in the spring, 2010 community comprising seven of the predominant taxa (above). The summer, 2011 community was characterised by seven of the taxa dominant in spring, together with an additional one 'moderately sensitive' and one 'tolerant' taxa, all of which previously had been predominantly characterisctic of this site's communities (Table 49) but without two of the 'moderately sensitive' taxa characteristic of the spring community. The increased abundances within some 'tolerant' taxa at the time of the summer survey was reflected in the small decline in $SQMCI_s$ scores (0.6 unit) between seasons (Tables 148 and 149). All taxa which were recorded as very abundant during spring and/or summer had characterised this site's communities on 78% to 100% of past surveys.

3.2.12.1.3 Predicted 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.

3.2.12.1.4 Temporal trends in 1995 to 2011 data

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the thirteen 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 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 45.



N = 25
Kendall tau = +0.331
p level = 0.020 [>FDR, p = 0.066]
Significant at p < 0.05 level;
N/S > FDR application

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

An overall improving temporal trend in MCI scores has been found (although not statistically significant after FDR application) over the thirteen 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 further upward trend. The range of LOWESS-smoothed scores (11 units) has been of marginal 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 a typically increased between spring and summer (but only by 6 units) at this mid reach site of a lowland stream where the percentage composition of 'tolerant' taxa decreased by 1% and, there was an increase of two 'highly sensitive' taxa (although only as rarities), in the summer community despite periphyton mats and filamentous algal substrate cover being more pronounced under much warmer water temperature conditions. Seasonal communities at this site shared 19 common taxa (59% of the 32 taxa found at this site in 2010-2011), a relatively high percentage of common taxa thereby contributing to the relatively small seasonal difference of 6 units in MCI values.

3.2.13 Punehu Stream

The results of the spring (2010) and summer (2010-2011) 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

Thirty surveys have been undertaken in the Punehu Stream between 1995 and February 2010 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000200	30	19-31	27	104-133	122	30	127	27	120

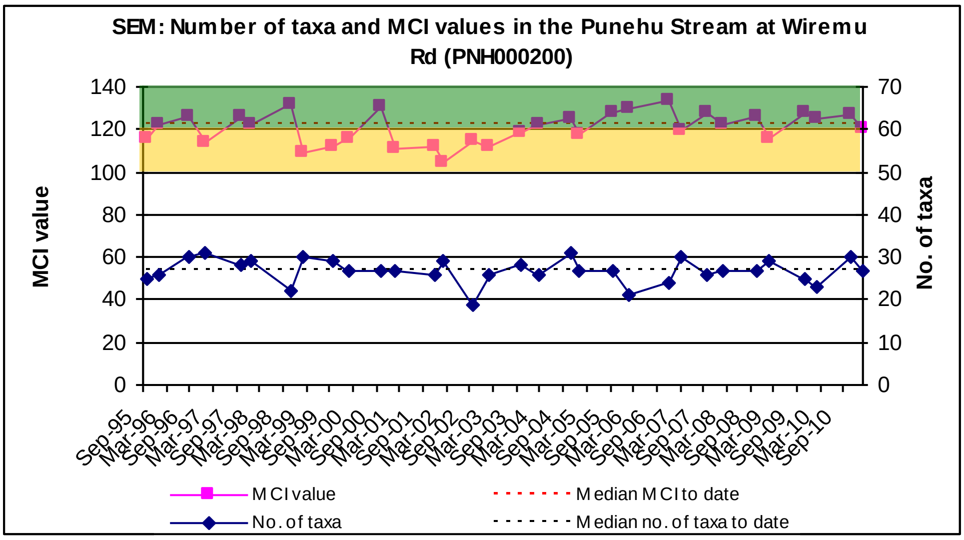


Figure 46 Numbers of taxa and MCI values in the Punehu Stream at Wiremu Road

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 2010-2011 period, spring (30 taxa) and summer (27 taxa) richnesses were slightly better than and equivalent with this median richness respectively.

MCI values have had a moderate range (29 units) at this site, typical of a site in the (upper) mid reaches of a ringplain stream in more open farmland. The median value (122 units) has been typical of mid reach sites elsewhere on the ringplain. The spring, 2010 (127 units) and summer, 2010 (120 units) scores were an insignificant 5 units above and 2 units below 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' and 'better than expected' health for the (upper) mid reaches of a ringplain stream in spring and summer respectively. The historical median score (122 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 prior to the 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	4	13		
MOLLUSCA	*Potamopyrgus*	4	1	3		
EPHEMEROPTERA	*Austroclima*	7	4	13	A	
	Coloburiscus	7	28	93	VA	VA
	Deleatidium	8	30	100	XA	XA
	Nesameletus	9	26	87	VA	VA
PLECOPTERA	*Acroperla*	5	2	7		
	Megaleptoperla	9	5	17		
	Zelandoperla	8	20	67	A	VA
COLEOPTERA	Elmidae	6	30	100	VA	VA
	Hydraenidae	8	5	17		
MEGALOPTERA	*Archichauliodes*	7	2	7		
TRICHOPTERA	*Aoteapsyche*	4	21	70	A	A
	Costachorema	7	18	60	A	
	Hydrobiosis	5	9	30		
	Beraeoptera	8	12	40	XA	XA
	Helicopsyche	10	3	10	A	
	Olinga	9	2	7		
	Oxyethira	2	1	3		
	Pycnocentrodes	5	19	63	A	A
DIPTERA	*Aphrophila*	5	5	17		
	Eriopterini	5	7	23		
	Maoridiamesa	3	13	43		
	Orthocladiinae	2	16	53	A	A
	Empididae	3	1	3		

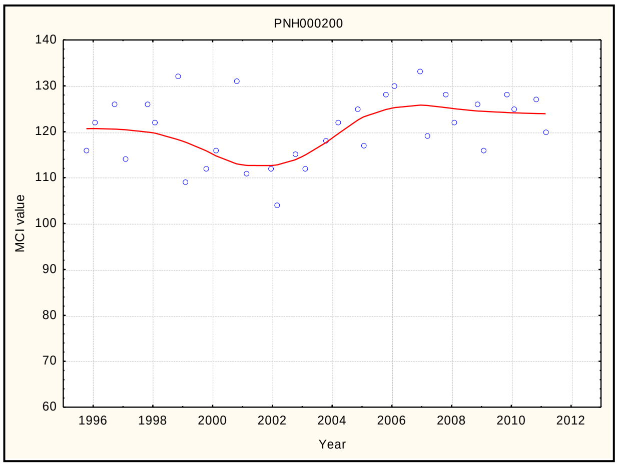
Prior to the current 2010-2011 period, 25 taxa have characterised the community at this site on occasions. These have comprised eight 'highly sensitive', ten 'moderately sensitive', and seven 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the (upper) mid reaches of a ringplain stream. Predominant taxa have included three 'highly sensitive' taxa (mayflies (*Deleatidium*) on every occasion, and *Nesameletus*) and stonefly (*Zelandoperla*)) ; five 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles (on very occasion), stony-cased caddisfly (*Pycnocentrodes*), and free-living caddisfly (*Costachorema*)); and two 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*) and orthoclad midges). Nine of these predominant taxa were dominant in the spring, 2010 community together with two other 'highly sensitive' and one other 'moderately sensitive' taxa while the summer, 2011 community was characterized by all but three of the taxa dominant in spring. All but one of these taxa previously had been predominantly characteristic of this site's communities (Table 51). The similarity in the seasonally most dominant taxa composition was evident in the identical $SQMCI_s$ 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 40% 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 (122 units) is 10 units higher than the altitude prediction and 7 units above the distance predictive value. The spring, 2010 survey score (127 units) was significantly (Stark, 1998) higher than both predictive values while the summer, 2011 score (120 units) was higher (by 8 units) than the altitude predictive value and 5 units above the distance predictive value. Of the 32 surveys to date at this site, only 9% of MCI scores have been less than 112 units while 75% have been greater than 115 units.

3.2.13.1.4 Temporal trends 1995 to 2011

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.212
p level = 0.088 [>FDR, p = 0.170]
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 entire period has not been statistically significant. The range of LOWESS-smoothed scores (13 units) has some ecologtical 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

Thirty surveys have been undertaken at this lower reach site at SH 45 in the Punehu Stream between 1995 and February 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000900	30	10-25	21	70-105	85	18	90	24	93

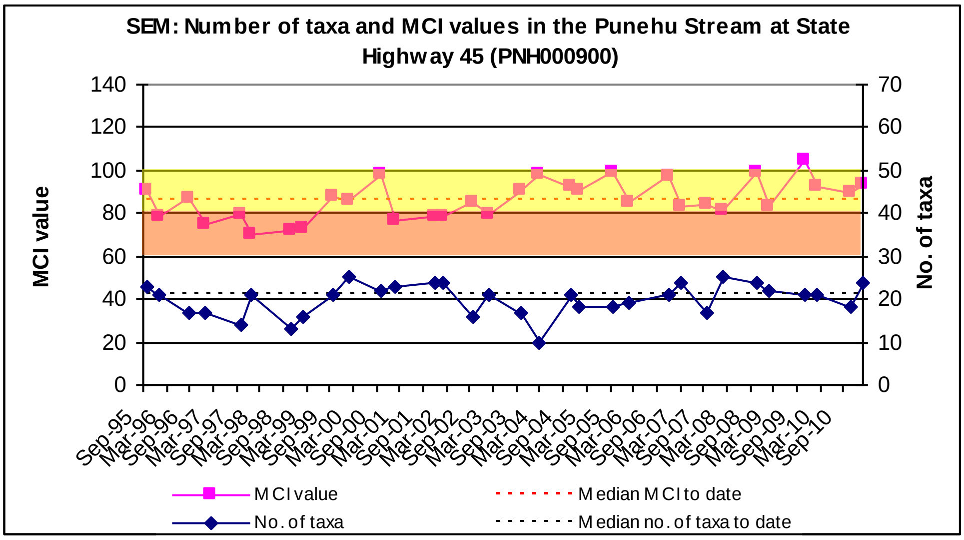


Figure 48 Numbers of taxa and MCI values in the Punehu Stream at SH 45

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 2010-2011 period, spring (18 taxa) and summer (24 taxa) richnesses varied but were within 3 taxa of the median taxa number on both occasions coincident with more widespread substrate periphyton cover in spring although water temperatures were higher at the time of the summer survey.
MCI scores have had a relatively wide range (35 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, 2010 (90 units) and summer, 2010 (93 units) scores were typical for such a site and higher than

the historical median by 5 and 8 units respectively. 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 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 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	27	90	A	A
MOLLUSCA	*Potamopyrgus*	4	15	50	A	A
EPHEMEROPTERA	*Austroclima*	7	0	0		A
	Coloburiscus	7	0	0		A
	Deleatidium	8	8	27	VA	XA
PLECOPTERA	*Acroperla*	5	0	0	A	
COLEOPTERA	Elmidae	6	18	60	VA	XA
MEGALOPTERA	*Archichauliodes*	7	3	10		A
TRICHOPTERA	*Aoteapsyche*	4	13	43		A
	Hydrobiosis	5	16	53		
	Oxyethira	2	4	13		
	Pycnocentrodes	5	8	27		A
DIPTERA	*Aphrophila*	5	16	53		VA
	Maoridiamesa	3	17	57		
	Orthocladiinae	2	29	97		
	Tanytarsini	3	8	27		A
	Ceratopogonidae	3	1	3		
	Empididae	3	6	20		
	Muscidae	3	2	7		
	Austrosimulium	3	3	10		

Prior to the current 2010-2011 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 four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), and midges (orthoclads and *Maoridiamesa*)). Four of the historically characteristic taxa and one additional taxon not previously characteristic at this site ('moderately sensitive' stonefly (*Acroperla*)) were dominant in the spring 2010 community.

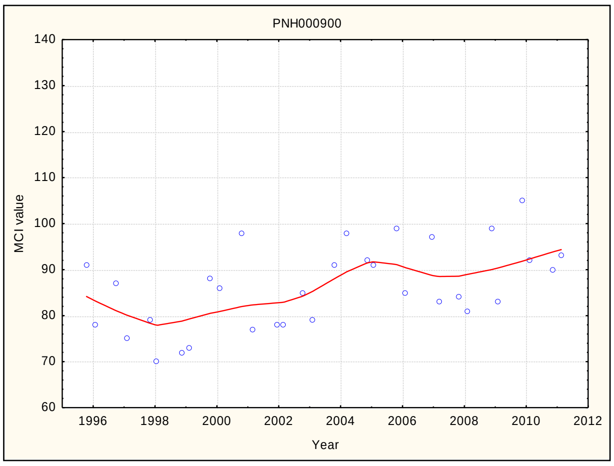
These comprised one 'highly sensitive', two 'moderately sensitive', and two 'tolerant' taxa, whereas one 'highly sensitive', six 'moderately sensitive', and four 'tolerant' taxa comprised the dominant taxa in the summer community. Two of these taxa ('moderately sensitive' mayflies (*Coloburiscus* and *Austroclima*) had not previously been characteristic of this site. Only four of these twelve taxa were dominant in both spring and summer communities (Table 55). Despite an increase in the proportional dominance by 'tolerant' taxa, increased numerical abundances within three 'moderately sensitive' taxa resulted in an increase in seasonal $SQMCI_s$ scores by 0.5 unit (Tables 150 and 151). The three taxa recorded as very or extremely abundant during spring and summer had characterised this site's communities on 27% to 60% of past surveys.

3.2.13.2.3 Predicted stream 'health'

The Punehu Stream site at SH 45 is 20.9 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and 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, 2010 survey score (90 units) was within 8 units of these predictive values and the summer, 2011 score (93 units) was within 7 units of predictive values. Of the 32 surveys to date at this site, 38% of MCI scores have been less than 86 units while only 13% have been greater than 98 units.

3.2.13.2.4 Temporal trends in 1995 to 2011

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006), has been performed on the sixteen 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 = 32
Kendall tau = +0.359
p level = 0.004 [>FDR, p = 0.020]
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 sixteen year period which was statistically significant ($p<0.05$) after FDR application.

The LOWESS-smoothed MCI scores' range (16 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 the last two years although issues remain with consented dairy shed discharge compliance and cumulative impacts of such discharges in the Mangatawa Stream sub-catchment in the local vicinity of the site (TRC, 2011).

3.2.13.3 Discussion

Seasonal MCI values typically deteriorated between spring and summer at the upper mid-reach (Wiremu Road) site, although only by 7 units, whereas an atypical but insignificant increase (3 units) was found at the lower reach site (SH 45). Seasonal communities at the upper mid reach site shared 22 common taxa (63% of the 35 taxa found at this site in 2010-2011) compared with 17 shared common taxa (45% of the 29 taxa found in 2010-2011) at the lower reaches site (SH 45), a typically more pronounced seasonal change in community structure at the lower of the two sites. The two sites shared 13 common taxa (37% of the 35 taxa) in spring and 16 common taxa (46% of 35 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and summer, but more so in spring.

MCI score typically fell in a downstream direction in both spring (by 37 units) and atypically less markedly in summer (by 27 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 2.2 units/km in springdecreasing to 1.6 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) emphasizing the impacts of diffuse and point-source discharges within this extensive dairying catchment.

Using the long-term median SEM MCI scores for both sites (Appendix II), the overall rate of decline has been 2.2 MCI units/km over the surveyed length. Therefore rates of decline over the 2010–2011 period were similar in spring and lower in summer to the historical average rate.

3.2.14 Patea River

The results of spring (2010) and summer (2010-2011) 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

Thirty surveys have been undertaken at this upper reach, shaded site adjacent to the National Park boundary in the Patea River between 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000200	30	26-35	31	127-145	137	25	138	31	138

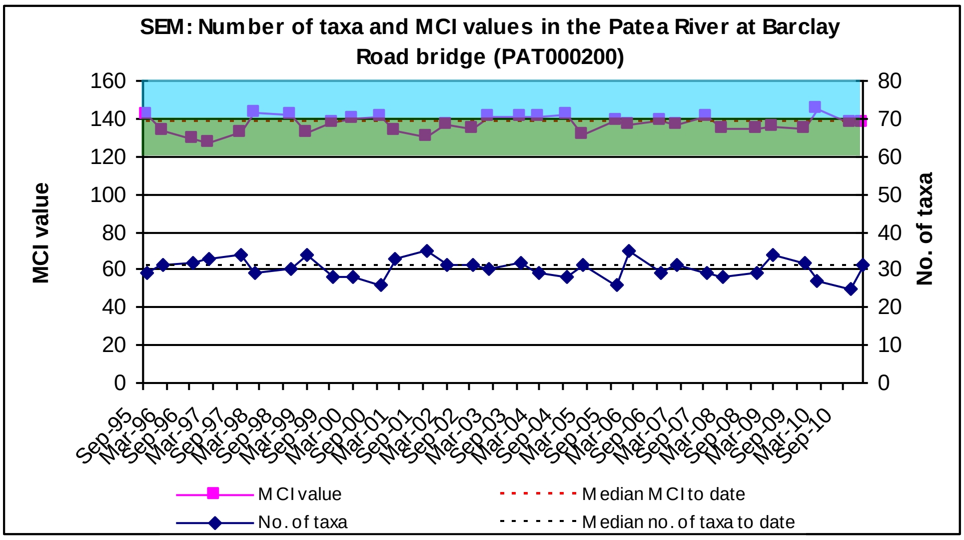


Figure 50 Numbers of taxa and MCI values in the Patea River at Barclay Road

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 2010-2011 period spring (25 taxa) richness was 6 taxa lower than the median and one fewer than the historical minimum at this site while summer (31 taxa) richnesses was equivalent with this median richness. This was coincident with very thin periphyton mat layers (spring) and more patchy periphyton cover (summer) on the predominantly stony-bouldery substrate of this shaded site.

MCI values have had a moderate range (18 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, 2010 (138 units) and summer, 2010 (138 units) scores continued this trend for such a site. These scores were one unit above the historical median and within seven units of the previous maximum value at this site.

They categorised this site as having 'very good' health generically (Table 1) on both occasions and, in terms of predictive relationships (Table 2), 'better than expected' health for the upper reaches of a ringplain stream on these occasions respectively. 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 2010-2011 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
EPHEMEROPTERA	*Austroclima*	7	5	17		
	Coloburiscus	7	30	100	A	XA
	Deleatidium	8	30	100	XA	VA
	Nesameletus	9	3	10		A
PLECOPTERA	*Austroperla*	9	1	3		
	Megaleptoperla	9	13	43		A
	Zelandobius	5	11	37	A	
	Zelandoperla	8	24	80		
	Elmidae	6	29	97		
COLEOPTERA	Hydraenidae	8	11	37		
	Archichauliodes	7	7	23		
MEGALOPTERA	*Costachorema*	7	1	3		
TRICHOPTERA	*Hydrobiosis*	5	1	3		
	Hydrobiosella	9	2	7		
	Orthopsyche	9	22	73	A	A
	Beraeoptera	8	15	50		
	Helicopsyche	10	13	43		
	Olinga	9	1	3		
	Zelolessica	7	1	3		
	Aphrophila	5	28	93	A	A
DIPTERA	Orthocladiinae	2	15	50	A	
	Polypedilum	3	1	3		

Prior to the current 2010-2011 period, 22 taxa had characterised the community at this site on occasions. These have comprised eleven 'highly sensitive', nine 'moderately sensitive', and two 'tolerant' taxa i.e. a majority of 'highly sensitive' taxa as would be expected near the National Park boundary of a ringplain river. Predominant taxa have included four 'highly sensitive' taxa (mayfly (*Deleatidium* on every sampling occasion), stonefly (*Zelandoperla*) and caddisflies (*Orthopsyche* and *Beraeoptera*)); three'moderately sensitive' taxa ((mayfly (*Coloburiscus* on every occasion), elmid beetles, and cranefly (*Aphrophila*)); and only one 'tolerant' taxon (orthoclad midges). Six of these characteristic taxa were dominant in the spring, 2010 community, with five of these predominant taxa.

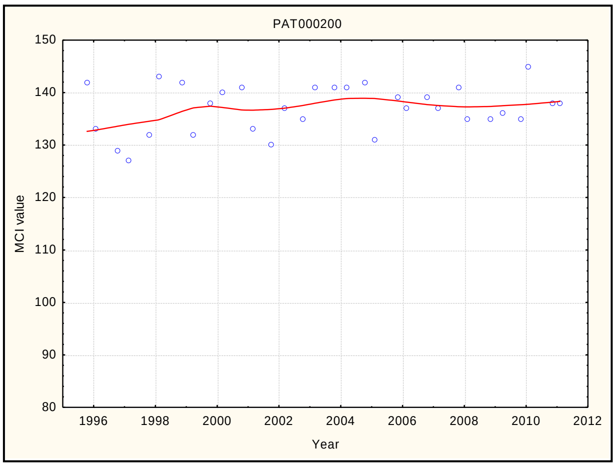
Four of these taxa again were dominant in the summer, 2011 community together with two other 'highly sensitive' taxa historically characteristic of this site. No 'tolerant' taxa were dominant in summer despite some patchy periphyton substrate cover at this site. The relatively similar balances between 'highly' and 'moderately' sensitive taxa dominances was illustrated in the small difference of 0.4 unit in $SQMCI_s$ values (Tables 152 and 153).The two taxa recorded as very or extremely abundant during spring and/or summer had characterized this site's communities on 100% of past surveys.

3.2.14.1.3 Predicted stream 'health'

The Patea River site at Barclay Road is 1.9 km downstream of the National Park boundary at an altitude of 500 m asl. Some bush cover extends from the National Park adjacent to most of the reach upstream of this site which is situated in farmland. Relationships for ringplain streams developed between MCI and 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, 2010 and summer, 2011 survey scores (138 units) were identical and higher than both these predictive values. Of the 32 surveys to date at this site, no MCI scores have been less than 125 units while 66% have been greater than 135 units.

3.2.14.1.4 Temporal trends in 1995 to 2011 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 = 32
Kendall tau = +0.087
p value = 0.483 [>FDR, p = 0.546]
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 16 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

Thirty surveys have been undertaken in the Patea River at this mid-reach site at Swansea Road, Stratford between 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000315	30	20-32	27	99-130	110	20	119	23	118

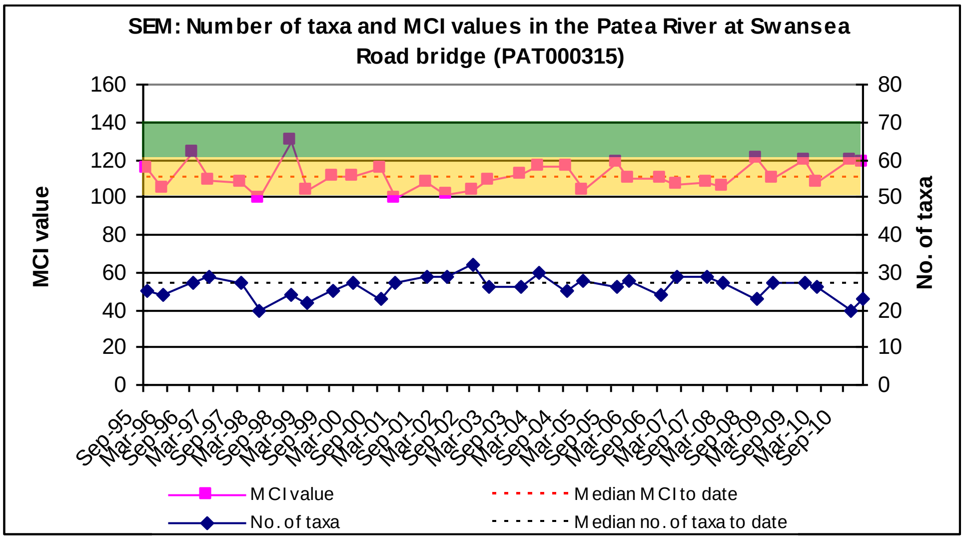


Figure 52 Numbers of taxa and MCI values in the Patea River at Swansea Road

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 2010-2011 period, spring (20 taxa) and summer (23 taxa) richnesses were relatively similar but lower than the median taxa number despite lower than usual substrate periphyton cover, particularly under spring conditions.

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 scores in mid-reach sites elsewhere on the ringplain however, with the spring, 2010 (119 units) and summer, 2010 (118 units) scores eight to nine units above 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 2010-2011 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	8	27		
EPHEMEROPTERA	*Austroclima*	7	13	43		
	Coloburiscus	7	30	100	XA	VA
	Deleatidium	8	23	77	XA	XA
	Nesameletus	9	10	33		A
PLECOPTERA	*Acroperla*	5	4	13		
	Zelandoperla	8	10	33	A	
COLEOPTERA	Elmidae	6	18	60	A	A
	Hydraenidae	8	4	13		
MEGALOPTERA	*Archichauliodes*	7	13	43		
TRICHOPTERA	*Aoteapsyche*	4	22	73	A	VA
	Costachorema	7	18	60		
	Hydrobiosis	5	5	17		
	Neurochorema	6	4	13		
	Beraeoptera	8	7	23	A	
	Pycnocentrodes	5	3	10	A	
DIPTERA	*Aphrophila*	5	26	87	A	A
	Eriopterini	5	1	3		
	Maoridiamesa	3	23	77		
	Orthocladiinae	2	28	93		A
	Tanytarsini	3	10	33		
	Muscidae	3	2	7		
	Austrosimulium	3	10	33		

Prior to the current 2010-2011 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; 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' taxa (mayfly (*Deleatidium*)); four 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Costachorema*), and cranefly (*Aphrophila*)); and three 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)). Eight of these historically characteristic taxa were dominant in the spring 2010 community. These comprised three 'highly sensitive' taxa, four 'moderately sensitive' taxa, and one 'tolerant' taxon, whereas two 'highly sensitive', three 'moderately sensitive', and two 'tolerant' taxa comprised the dominant taxa of the summer community. Five of these ten taxa were dominant in both spring and summer communities (Table 57). The relatively similar seasonal dominances amongst the three most abundant of these taxa were reflected in the small difference (0.2 unit) in $SQMCI_s$ scores (Tables 152 and 153).

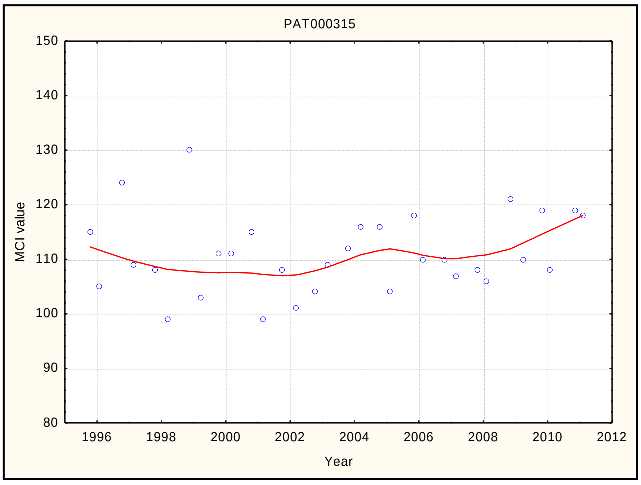
The three taxa found as very and/or extremely abundant by the seasonal surveys have characterised this site's communities on 73% to 100% of past survey occasions.

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, 2010 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 very similar summer, 2011 score (118 units) was within 15 units of both predictive values. Of the 32 surveys to date at this site, 9% of MCI scores have been less than 103 units while 28% have been greater than 115 units.

3.2.14.2.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.154
p value = 0.216 [>FDR, p = 0.328]
N/S at $p < 0.05$

Figure 53 LOWESS trend plot at the Swansea Road site

The small positive temporal trend in MCI scores was not statistically significant over the sixteen year period. The range of LOWESS-smoothed scores (11 units) was of marginal ecological significance. 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

Thirty 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 February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000360	32	15-33	24	86-105	97	25	105	23	97

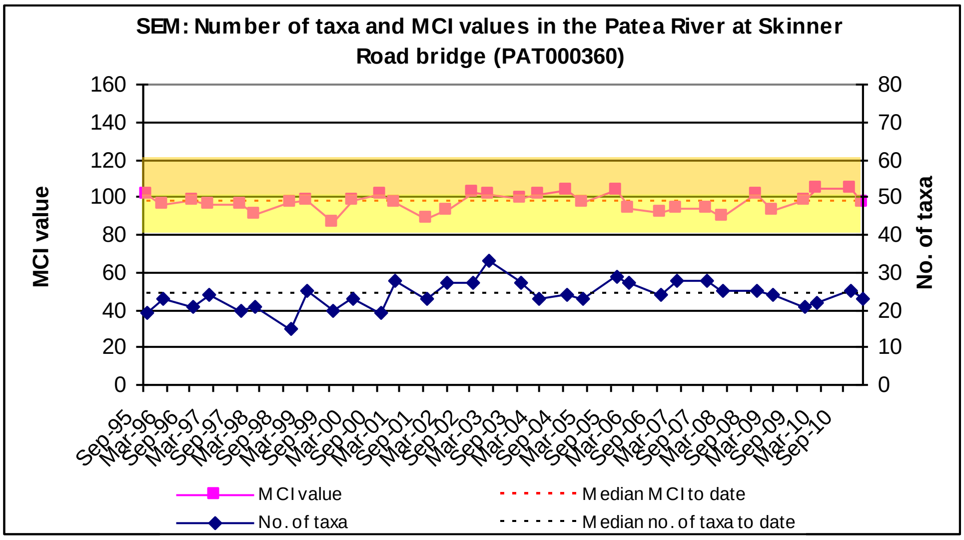


Figure 54 Numbers of taxa and MCI values in the Patea River at Skinner Road

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 2010-2011 period spring (25 taxa) and summer (23 taxa) richnesses were similar and within one taxon of the median taxa number on both occasions.

MCI values have had a moderate range (19 units) at this site, typical of sites in the mid-reaches of ringplain streams and rivers. The median value (97 units) has been relatively typical of the range of scores at mid-reach sites elsewhere on the ringplain however. The spring, 2010 (105 units) and summer, 2011 (97 units) scores were relatively similar, typical of scores for such a site, and 8 units higher (spring) and equal with (summer) the historical median. These scores categorised this site as having 'good' (spring) to 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' to '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.

3.2.14.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	5	17		
ANNELIDA	Oligochaeta	1	22	73		A
MOLLUSCA	*Potamopyrgus*	4	10	33		
CRUSTACEA	*Paracalliope*	5	1	3		
EPHEMEROPTERA	*Austroclima*	7	1	3		
	Coloburiscus	7	7	23	VA	
	Deleatidium	8	9	30	XA	XA
PLECOPTERA	*Acroperla*	5	2	7		
COLEOPTERA	Elmidae	6	22	73	VA	VA
MEGALOPTERA	*Archichauliodes*	7	10	33	A	A
TRICHOPTERA	*Aoteapsyche*	4	23	77	A	VA
	Costachorema	7	8	27	A	
	Hydrobiosis	5	15	50	A	
	Oxyethira	2	4	13		
	Pycnocentrodes	5	6	20	A	
DIPTERA	*Aphrophila*	5	21	70	A	VA
	Maoridiamesa	3	25	83	XA	
	Orthocladiinae	2	30	100	A	A
	Tanytarsini	3	15	50		
	Empididae	3	2	7		
	Muscidae	3	8	27		
	Austrosimulium	3	8	27		

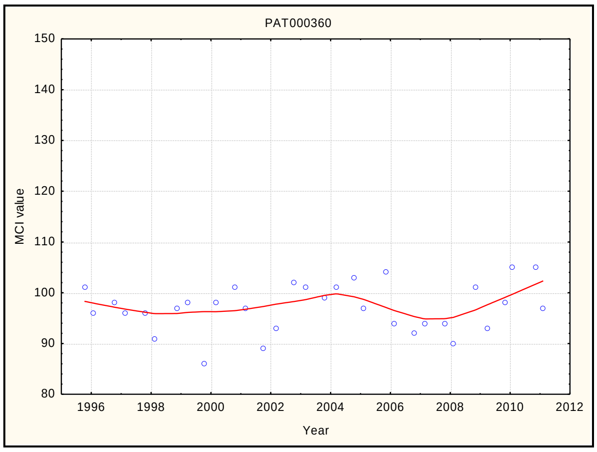
Prior to the current 2010-2011 period, 22 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportions of 'moderately sensitive' and 'tolerant' taxa as would be expected in the mid-reaches of a ringplain river. Predominant taxa have included three 'moderately sensitive' taxa (elmid beetles, free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)) and five 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa*, tanytarsids and orthoclads)). Eleven of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive', seven 'moderately sensitive', and three 'tolerant' taxa, whereas one 'highly sensitive', three 'moderately sensitive', and three 'tolerant' taxa comprised the dominant taxa of the summer, 2011 community. Six of these twelve taxa were dominant in both spring and summer communities (Table 61). An atypical decrease in summer numberical dominance by one 'tolerant' taxon (midge (*Maoridiamesa*)) in particular was reflected in the increase of 1.0 unit 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 23% to 83% of past survey occasions and a majority 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, 2010 survey score (105 units) was 4 units lower than the altitude predictive value while the summer, 2011 score (97 units) was 12 units lower than the predictive altitude value and 2 units below the predicted distance value. Of the 32 surveys to date at this site, 66% 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 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.112
p value = 0.366 [>FDR, p = 0.476]
N/S at $p < 0.05$

Figure 55 LOWESS trend plot at the Skinner Road site

The small positive temporal trend in MCI scores over the sixteen 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 (8 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 sixteen year period, bordering on 'better than expected' very recently.

3.2.14.4 Discussion

Seasonal MCI values remained very similar between spring and summer at two sites (typically at Barclay Road and atypically at Swansea Road) while at the Skinner Road, site a more typical summer decrease in MCI score (8 units) was recorded. Seasonal communities shared 70% of the 33 taxa at the upper site, 59% of 27 taxa at Swansea Road, and 66% of 29 taxa at the furthest downstream site in the middle reaches indicative of increased dissimilarities in seasonal community composition in the mid-reaches downstream of the Barclay Road site.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream middle reaches site by 33 units in spring and 41 units in summer, over a river distance of 17.3 km. These seasonal falls in MCI scores equated to rates of decline of 1.9 units/km (spring) and 2.4 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 (1.2 units/km) and summer (1.8 units/km) rates of decline were lower 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 (1.7 units/km) and summer (3.5 units/km) rates of decline were far 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 reach and Swansea Road mid-reach, and the Swansea Road mid-reach and Skinner Road mid-reach sites have been about 2.6 and 2.1 units per km respectively with an overall average rate of decline of 2.4 MCI units/km over the surveyed length. Therefore rates of MCI decline in the 2010-2011 period were mainly lower, but more variable in summer, than average rates for the 1995 to 2010 period for the various surveyed reaches of the river.

Community composition varied markedly through the upper to mid-reach length of the river surveyed. A total of 36 taxa was recorded in spring of which only 13 taxa were present at all three sites. These included four 'highly sensitive', seven 'moderately sensitive', and two 'tolerant' taxa with only the 'highly sensitive' ubiquitous mayfly *Deleatidium*; and two 'moderately sensitive' taxa (mayfly (*Coloburiscus*), and cranefly (*Aphrophila*)) abundant at all three sites. A slightly higher total of 41 taxa was found along the river's length by the summer survey of which 13 taxa also were present at all three sites. These were very similar to the widespread taxa in spring with the addition of one 'moderately sensitive' and one 'tolerant' taxa and loss of two 'highly sensitive' taxa. Only the one 'highly sensitive' mayfly taxon and one 'moderately sensitive' taxon 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 slightly more pronounced in summer.

3.2.15 Mangaehu River

The results found by the 2010-2011 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)

3.2.15.1.1 Taxa richness and MCI

Twenty eight surveys have been undertaken at this lower reach site in the Mangaehu River between 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2010	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGH000950	30	13-26	19	77-104	88	19	93	20	95

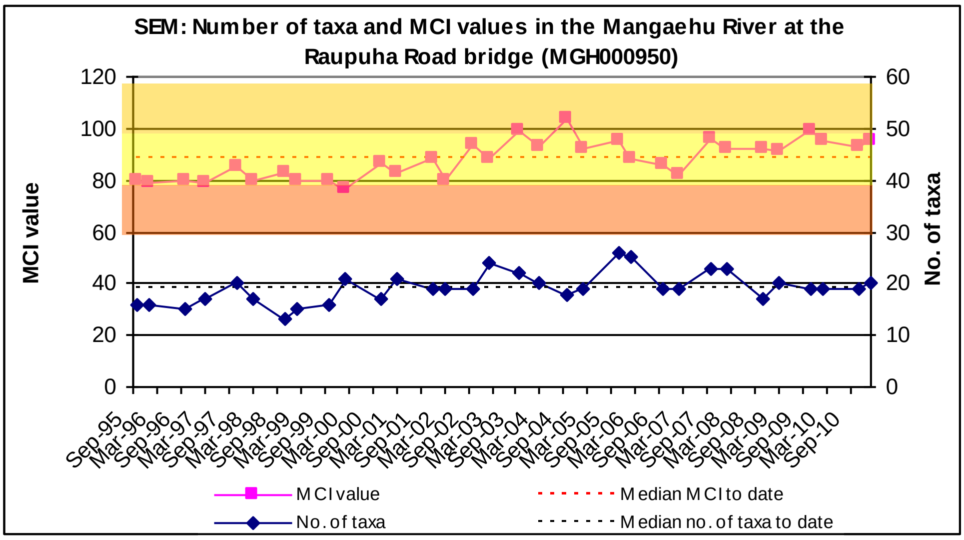


Figure 56 Numbers of taxa and MCI values in the Mangaehu River at Raupuha Road

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 2010-2011 period, spring (19 taxa) and summer (20 taxa) richnesses were very similar to this median richness.

MCI values have had a relatively wide range (27 units) at this site and typical of a site in the lower reaches of streams and rivers. The median value (88 units) has been more typical of lower reach sites elsewhere and one unit less than the median score (92 units) recorded by 43 previous surveys at 'control' sites located at similar altitudes (to the Raupuha Road site) in eastern hill country rivers and streams (TRC, 1999 (updated, 2011)). The spring, 2010 (93 units) and summer, 2011 (95 units) scores were 5 to 7 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 (88 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 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	1	3		
ANNELIDA	Oligochaeta	1	4	13		
MOLLUSCA	*Potamopyrgus*	4	9	30		
CRUSTACEA	*Paracalliope*	5	5	17		
EPHEMEROPTERA	*Austroclima*	7	4	13	A	A
	Deleatidium	8	0	0		A
	Mauiulus	5	1	3		
	Zephlebia group	7	2	7		A
PLECOPTERA	*Acroperla*	5	8	27		
COLEOPTERA	Elmidae	6	3	10		A
TRICHOPTERA	*Aoteapsyche*	4	17	57		A
	Costachorema	7	5	17		
	Hydrobiosis	5	14	47		
	Oxyethira	2	2	7		
	Pycnocentrodes	5	11	37		A
DIPTERA	*Aphrophila*	5	24	80	A	
	Maoridiamesa	3	20	67	A	
	Orthocladiinae	2	28	93	A	A
	Tanytarsini	3	11	37		A
	Empididae	3	4	13		
	Muscidae	3	7	23		
	Austrosimulium	3	6	20		

Prior to the current 2010-2011 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 only one 'moderately sensitive' taxa (cranefly (*Aphrophila*)) and three 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)). Three of these predominant taxa were dominant in the spring, 2010 community together with one other historically characteristic taxon. The summer, 2011 community was characterised by fewer of the taxa dominant in spring, together with an additional six taxa; five of which previously had been characteristic of this site's communities (Table 61) and one 'highly sensitive' taxon (mayfly (*Deleatidium*)) which had been recorded at this site previously, but never in abundance. Several seasonal differences in characteristic taxa, particularly an atypical increase in the proportion of 'sensitive' taxa in the summer survey was reflected in the increase of 0.8 unit in seasonal $SQMCI_s$ scores (Tables 154 and 155).

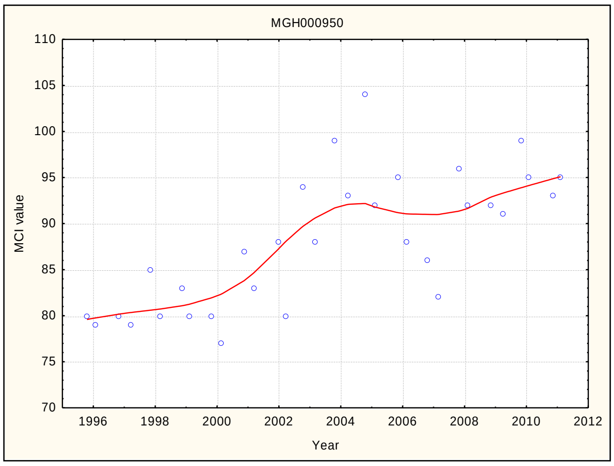
No taxa were recorded as very or extremely abundant during spring and/or summer surveys.

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. Relationships for ringplain streams and river developed between MCI and altitude and distance from the National Park (Stark and Fowles, 2009) are therefore not appropriate for this river.

3.2.15.1.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen years (1995-2011) 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 = 32
Kendall tau = +0.544
p value < 0.0001 [>FDR, p = 0.0001]
Significant at p<0.05 and p<0.01

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

A very strong, statistically 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 more recently. The range of LOWESS-smoothed MCI scores (15 units) has also been ecologically significant, particularly over the period since 2000.

Smoothed MCI scores originally 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 atypically increased (although only by 2 units) between spring and summer at this lower reach site with the percentage community composition of 'tolerant' taxa very similar (within 3%) at the time of the spring and summer surveys. However, seasonal communities at this site shared 16 common taxa (70% of the 23 taxa found at this site in 2010-2011), a moderately high percentage of common taxa accounting for the similarity in MCI values for the seasonal surveys.

3.2.16 Waingongoro River

The results of spring (2010) and summer (2010-2011) surveys are summarised in Table 156 and Table 156, Appendix I.

3.2.16.1 Site near National Park boundary (WGG000115)

3.2.16.1.1 Taxa richness and MCI

Thirty surveys have been undertaken at this upper reach site, 700m downstream of the National Park boundary in the Waingongoro River, between 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000115	30	24-40	32	122-139	133	33	131	31	128

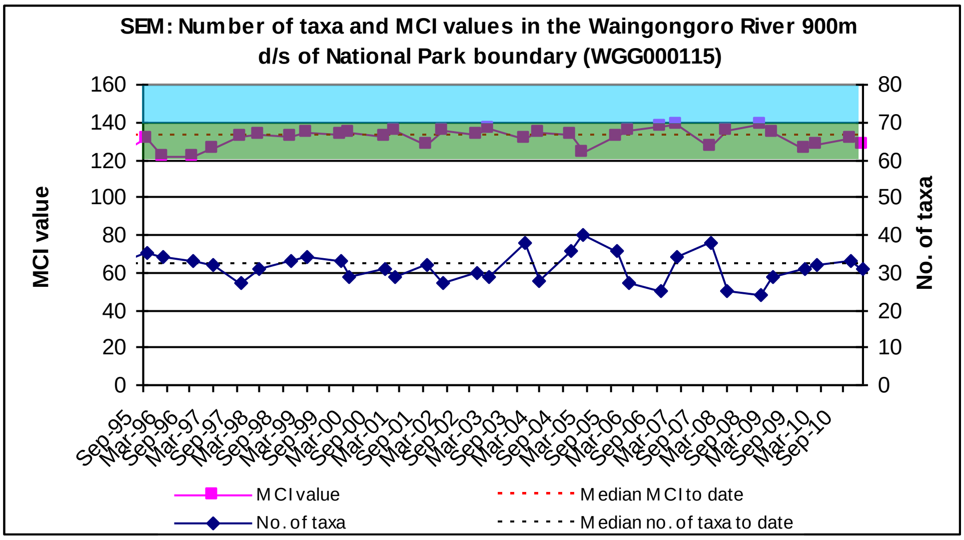


Figure 58 Numbers of taxa and MCI values in the Waingongoro River 700 m d/s National Park

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 2010-2011 period spring (33 taxa) and summer (31 taxa) richnesses were within one taxon of 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, 2010 (131 units) and summer, 2010 (128 units) scores were within 5 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), '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 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
EPHEMEROPTERA	*Austroclima*	7	18	60	VA	A
	Coloburiscus	7	30	100	VA	VA
	Deleatidium	8	30	100	XA	XA
	Nesameletus	9	15	50	A	VA
PLECOPTERA	*Acroperla*	5	3	10		
	Austroperla	9	1	3		
	Megaleptoperla	9	27	90	A	A
	Stenoperla	10	3	10		
	Zelandobius	5	2	7		
	Zelandoperla	8	30	100	VA	VA
COLEOPTERA	Elmidae	6	30	100	VA	VA
	Hydraenidae	8	22	73		A
MEGALOPTERA	*Archichauliodes*	7	7	23		
TRICHOPTERA	*Aoteapsyche*	4	27	90	A	A
	Beraeoptera	8	23	77	VA	VA
	Helicopsyche	10	15	50	VA	
	Olinga	9	22	73		
	Pycnocentrodes	5	1	3		
	Zelolessica	7	9	30	A	A
DIPTERA	*Aphrophila*	5	30	100	VA	A
	Maoridiamesa	3	2	7		
	Orthocladiinae	2	14	47		A

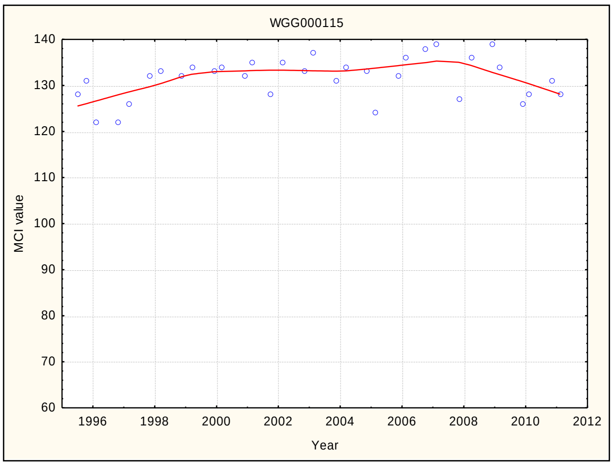
Prior to the current 2010-2011 period, 22 taxa had characterised the community at this site on occasions. These have comprised ten 'highly sensitive', nine 'moderately sensitive', and three 'tolerant' taxa i.e. a high proportion of 'highly sensitive' taxa as might be expected in the upper reaches of a ringplain river near the National Park. Predominant taxa have included eight 'highly sensitive' taxa (mayflies (*Nesameletus* and *Deleatidium*), stoneflies (*Megaleptoperla* and *Zelandoperla*), hydraenid beetles, and cased caddisflies (*Beraeoptera*, *Helicopsyche* and *Olinga*)); four 'moderately sensitive' taxa (mayflies (*Coloburiscus* and *Austroclima*), elmid beetles and cranefly (*Aphrophila*)); and only one 'tolerant' taxon (free-living caddisfly (*Aoteapsyche*)). 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, 2010 community. These comprised six 'highly sensitive' taxa, five 'moderately sensitive' taxon, and one 'tolerant' taxon, whereas six 'highly sensitive' taxa, five 'moderately sensitive' taxa, and two 'tolerant' taxa comprised the dominant taxa of the summer, 2011 community. Eleven of these fourteen taxa were dominant in both spring and summer communities. All five taxa dominant on every previous survey occasion were included amongst these eleven taxa (Table 63). The relatively similar seasonal dominances by high proportions of 'sensitive' taxa were reflected in the identical seasonal $SQMCI_S$ 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, 2010 survey score (131 units) was 9 units lower than the altitude predictive value and the summer, 2011 score (128 units) was significantly lower (Stark, 1998) than this predictive value but both were similar to the distance predictive value. Of the 32 surveys to date at this site, 28% 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 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 33
Kendall tau = +0.203
p value = 0.096 [>FDR, p = 0.172]
N/S at p<0.05

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

A temporal trend of some improvement in MCI scores has been found over the sixteen year period. This has not been statistically significant at the 5% level however, although previously there has been a limited statistically significant improvement over a shorter period. 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 remained 'expected' throughout the sixteen year period, although it bordered on 'better than expected' between 2006 and 2008.

3.2.16.2 Opunake Road site (WGG000150)

3.2.16.2.1 Taxa richness and MCI

Thirty 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 February 2010. 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 together with spring 2010 and summer 2011 results.

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000150	30	24-39	28	119-139	129	25	133	25	130

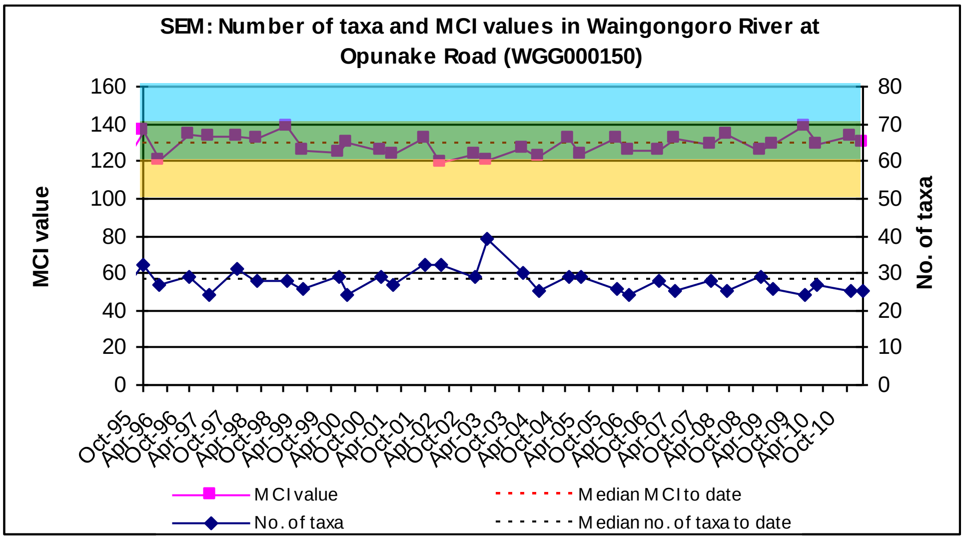


Figure 60 Numbers of taxa and MCI values in the Waingongoro River at Opunake Road

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 2010-2011 period spring (25 taxa) and summer (25 taxa) richnesses were identical and slightly below median taxa number coincidental with minimal substrate periphyton cover on both occasions.

MCI values have had a moderate range (20 units) at this site, typical of sites in the upper mid reaches of ringplain rivers. The median value (129 units) has been higher than typical of mid reach sites elsewhere on the ringplain however, with the spring, 2010 (133 units) and summer, 2011 (130 units) scores above those typical for such a site and 1 to 14 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

(129 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 2010-2011 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	2	6		
EPHEMEROPTERA	*Austroclima*	7	22	71	A	A
	Coloburiscus	7	31	100	VA	XA
	Deleatidium	8	31	100	XA	XA
	Nesameletus	9	25	81	A	A
PLECOPTERA	*Acroperla*	5	1	3		
	Megaleptoperla	9	2	6		
	Zelandoperla	8	22	71	A	A
COLEOPTERA	Elmidae	6	31	100	VA	A
	Hydraenidae	8	20	65		
MEGALOPTERA	*Archichauliodes*	7	18	58	A	A
TRICHOPTERA	*Aoteapsyche*	4	25	81	A	A
	Costachorema	7	1	3		
	Hydrobiosis	5	3	10		
	Beraeoptera	8	25	81	VA	VA
	Confluens	5	2	6		
	Helicopsyche	10	1	3	A	
	Olinga	9	8	26		
	Pycnocentrodes	5	13	42		
DIPTERA	*Aphrophila*	5	31	100	A	VA
	Eriopterini	5	1	3		
	Orthocladiinae	2	6	19		

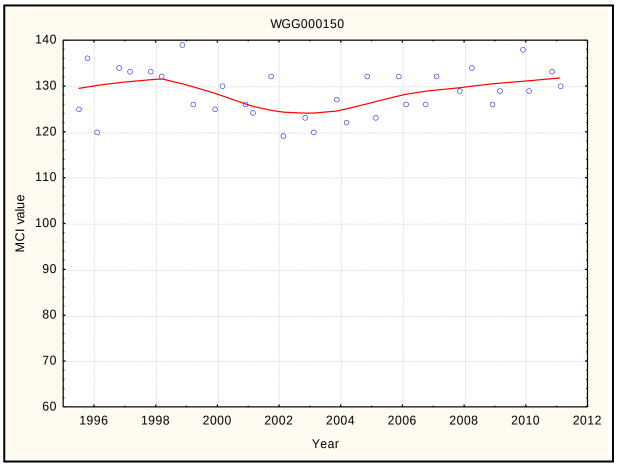
Prior to the current 2010-2011 period, 22 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', eleven 'moderately sensitive', and three 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected toward the upper mid-reaches of a 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*)); five 'moderately sensitive' taxa (mayflies (*Coloburiscus* and *Austroclima*), elmid beetles, dobsonfly (*Archichauliodes*), and cranefly (*Aphrophila*)); and one 'tolerant' taxon (net-building caddisfly (*Aoteapsyche*)). Eleven of the characteristics taxa were dominant in the spring, 2010 community. These were comprised of five 'highly sensitive', five 'moderately sensitive', and one 'tolerant' taxa. Ten of these taxa were again dominant in the summer, 2011 community when only one fewer 'highly sensitive' taxon was dominant. One taxon ('highly sensitive' mayfly, *Deleatidium*) was recorded as extremely abundant in both spring and summer communities. The numerical dominance by similar 'highly sensitive' and 'moderately sensitive' taxa in both seasons was refleted in the similarity in seasonal $SQMCI_s$ values which differed by only 0.3 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 80% to 100% of past surveys.

3.2.16.2.3 Predicted stream 'health'

The Waingongoro River site at Opunake Road is 7.2 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and 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 (129) is 6 units higher than the altitude prediction and a significant (Stark, 1998) 19 units higher than the distance predictive value while the spring, 2010 survey score (133 units) was higher than both predictive values. The summer, 2011 score (130 units) was higher than both predictive values by 7 to a significant 20 units. Of the 32 surveys to date at this site, no MCI scores have been less than 110 units while 81% have been greater than 123 units, further indicative of the better than predicted health of the river at this site.

3.2.16.2.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 33
Kendall tau = +0.033
p value = 0.786 [>FDR, p = 0.817]
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 increase in MCI scores has not been statistically significant at this site in the upper mid-reaches of the river (some 7 km below the National Park). The LOWESS-smoothed range of scores (8 units) has also been ecologically insignificant over the sixteen year period. Localised erosion had caused sediment deposition on the riverbed during 1999 with a subsequent five year decline in MCI scores which was of no ecological significance (LOWESS-smoothed range of 7 units). This decline ceased with a gradual improvement in MCI scores towards earlier levels over the latter eight 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-four surveys have been undertaken in the Waingongoro River at this mid-reach site at Eltham Road between October 1995 and February 2010. 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, together with spring 2010 and summer 2011 results.

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000500	34	16 - 32	23	91-115	101	18	103	20	100

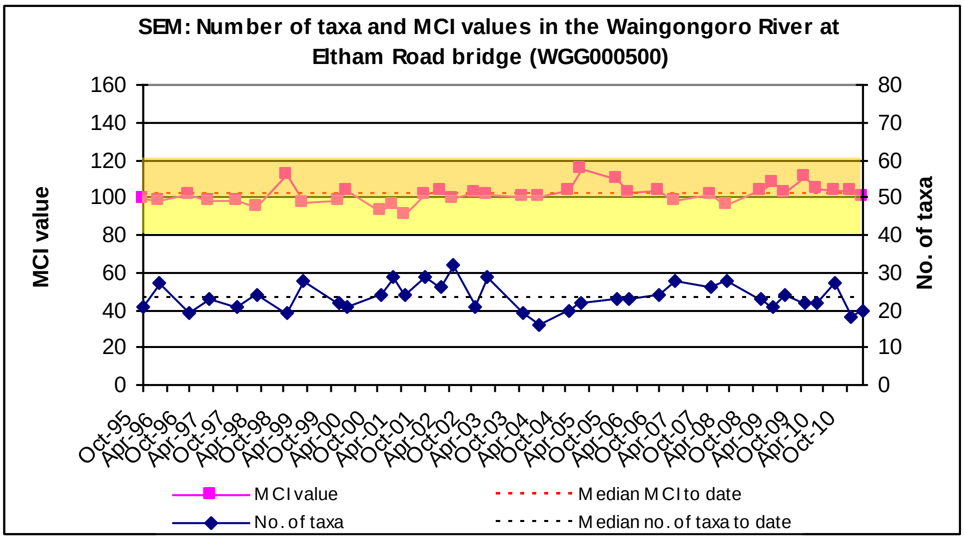


Figure 62 Numbers of taxa and MCI values in the Waingongoro River at Eltham Road

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 2010-2011 period spring (18 taxa) and summer (20 taxa) richnesses were similar but were 3 to 5 taxa lower than 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, 2010 (103 units) and summer, 2010 (100 units) scores typical for such a site and within 2 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' (spring) and 'expected' (summer) health 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.

3.2.16.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 February 2010 [34 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	4	12		
ANNELIDA	Oligochaeta	1	12	35		
MOLLUSCA	*Potamopyrgus*	4	7	21		
EPHEMEROPTERA	*Austroclima*	7	8	24		
	Coloburiscus	7	17	50	A	A
	Deleatidium	8	23	68	XA	XA
PLECOPTERA	*Zelandobius*	5	5	15		
COLEOPTERA	Elmidae	6	32	94	VA	XA
MEGALOPTERA	*Archichauliodes*	7	19	56		A
TRICHOPTERA	*Aoteapsyche*	4	29	85	A	VA
	Costachorema	7	16	47		
	Hydrobiosis	5	23	68		
	Beraeoptera	8	1	3		
	Oxyethira	2	2	6		
	Pycnocentrodes	5	9	26		A
DIPTERA	*Aphrophila*	5	7	21		
	Eriopterini	5	6	18		
	Maoridiamesa	3	17	50		
	Orthocladiinae	2	23	68		
	Tanytarsini	3	9	26		
	Ceratopogonidae	3	1	3		
	Empididae	3	3	9		
	Austrosimulium	3	13	38		

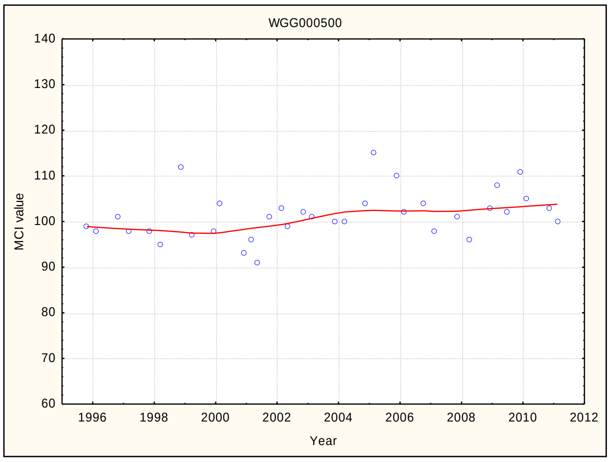
Prior to the current 2010-2011 period, 23 taxa had characterised the community at this site on occasions. These have comprised two 'highly sensitive', ten 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increase in 'tolerant' taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); four 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Hydrobiosis*), and dobsonfly (*Archichauliodes*)); and three 'tolerant' taxa (free-living caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)). Four of these historically characterisctic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive' taxon, two 'moderately sensitive' taxa, and one 'tolerant' taxon, whereas the same four taxa and two additional 'moderately sensitive' taxa comprised the dominant taxa of the summer community. Four of these six taxa were dominant in both spring and summer communities (Table 67). Despite relatively similar seasonal dominances, there was a small decrease (0.8 unit) in $SQMCI_s$ scores between spring and summer principally due to increased numerical abundances of one 'moderately sensitive' and one 'tolerant' taxa in summer (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 68% to 94% 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, 2010 survey score (103 units) was 2 units lower to 6 units above predictive values and the summer, 2010 score (105 units) was 5 units below the predictive altitude value and 3 units above the predictive distance value. Of the 35 surveys to date at this site, 14% of MCI scores have been less than 97 units while 14% have been greater than 105 units.

3.2.16.3.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 35
Kendall tau = +0.305
p value = 0.010 [>FDR, p = 0.034]
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 sixteen-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 (7 units) has no ecological significance over the sixteen 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 consistently '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

Thirty surveys have been undertaken in the Waingongoro River at this mid-reach site at Stuart Road between 1995 and February, 2010. 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, together with spring 2010 and summer 2011 results.

Site code	SEM data (1995 to Feb 2010)						2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000665	30	14-30	20	77-105	93	17	104	18	98

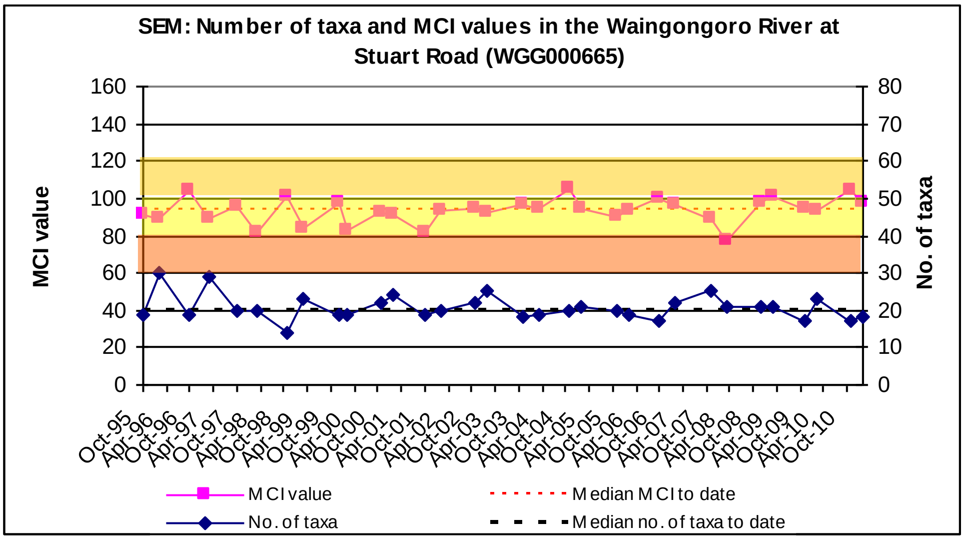


Figure 64 Numbers of taxa and MCI values in the Waingongoro River at Stuart Road

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 2010-2011 period spring (17 taxa) and summer (18 taxa) richnesses were very similar and slightly lower than the median taxa number in spring and in summer, coincidental with patchy substrate periphyton cover on both occasions.

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, 2010 (104 units) and summer, 2011 (98 units) scores relatively typical of this site but 5 to a significant 11 units above the historical median. 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. Improvements in biological 'health', as indicated by the higher than median scores (and the spring score which was within 1 unit of the historical maximum), have been coincidental with the July 2010 diversion of the major point source discharge (Eltham municipal wastewater) out of the catchment, a short distance upstream of this site. 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 2010-2011 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	1	3		
ANNELIDA	Oligochaeta	1	18	60		
CRUSTACEA	Ostracoda	1	1	3		
EPHEMEROPTERA	*Austroclima*	7	5	17		
	Coloburiscus	7	1	3		
	Deleatidium	8	14	47	XA	XA
PLECOPTERA	*Zelandobius*	5	2	7		
COLEOPTERA	Elmidae	6	23	77	VA	VA
TRICHOPTERA	*Aoteapsyche*	4	25	83		A
	Costachorema	7	6	20		
	Hydrobiosis	5	12	40		
	Oxyethira	2	1	3		
	Pycnocentrodes	5	2	7	VA	VA
DIPTERA	*Aphrophila*	5	12	40		
	Maoridiamesa	3	22	73	A	A
	Orthocladiinae	2	30	100	A	VA
	Tanytarsini	3	8	27		
	Ceratopogonidae	3	1	3		
	Empididae	3	2	7		
	Austrosimulium	3	11	37		

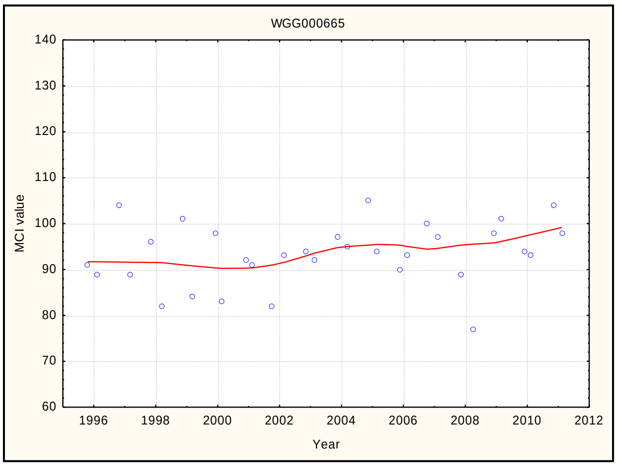
Prior to the current 2010-2011 period, 20 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', eight 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a higher proportion of 'tolerant' taxa as might be expected in the mid reaches of a ringplain river. Predominant taxa have included no 'highly sensitive' taxa; one 'moderately sensitive' taxon (elmid beetles); and four 'tolerant' taxa (oligochaete worms, free-living caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)). Five of these historically characteristic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive' taxon, two 'moderately sensitive' taxa, and three 'tolerant' taxa, whereas all these five taxa plus one additional 'tolerant' taxon comprised the dominant taxa of the summer community. Five of six 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) were reflected in the small difference (0.6 unit) in seasonal $SQMCI_s$ scores (Tables 156 and 157). All taxa (four) recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 7% to 100% of past survey occasions.

3.2.16.4.3 Predicted stream 'health'

The Waingongoro River site at Stuart Road is 29.6 km downstream of the National Park boundary at an altitude of 180 m asl. Relationships for ringplain streams developed between MCI and 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, 2010 survey score (104 units) was up to 10 units higher than these predictive values and the summer, 2011 score (98 units) was within 5 units of both predictive values. Of the 32 surveys to date at this site, 53% of MCI scores have been less than 94 units while only 9% have been greater than 103 units.

3.2.16.4.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.214
p value = 0.085 [>FDR, p = 0.170]
N/S at p <0.05

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

No overall statistically significant trend in 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 land irrigation) and most recently, the diversion of treated municipal Eltham wastewater out of the catchment (to the Hawera WWTP and ocean outfall). The LOWESS-smoothed range of scores (9 units) was also ecologically insignificant over the sixteen 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

Thirty-one surveys have been undertaken in the Waingongoro River at this lower reach site at SH45 between 1995 and February, 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000895	31	16-24	21	73-105	95	20	93	18	97

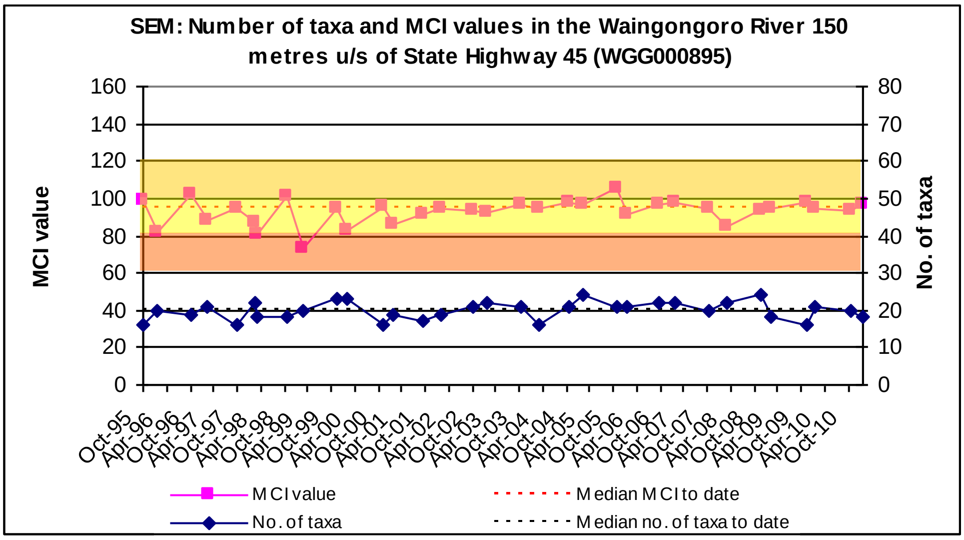


Figure 66 Numbers of taxa and MCI values in the Waingongoro River 150 m u/s of SH45

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 2010-2011 period spring (20 taxa) and summer (18 taxa) richnesses varied by only two taxa with the summer richness lower than the median taxa number by 3 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, 2011)), however. The spring, 2010 (93 units) and summer, 2010 (97 units) scores were similar, typical of scores at this site, and were 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 (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 2010-2011 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	3	10		
ANNELIDA	Oligochaeta	1	25	81	A	A
	Lumbricidae	5	4	13		
MOLLUSCA	*Latia*	5	2	6		
	Potamopyrgus	4	29	94	A	VA
EPHEMEROPTERA	*Austroclima*	7	3	10		
	Deleatidium	8	14	45	VA	A
PLECOPTERA	*Zelandobius*	5	3	10		
COLEOPTERA	Elmidae	6	31	100	A	VA
MEGALOPTERA	*Archichauliodes*	7	3	10		
TRICHOPTERA	*Aoteapsyche*	4	31	100	A	A
	Costachorema	7	2	6		
	Hydrobiosis	5	17	55		
	Pycnocentrodes	5	29	94	VA	VA
DIPTERA	*Aphrophila*	5	10	32		
	Maoridiamesa	3	16	52	A	
	Orthocladiinae	2	19	61	A	
	Tanytarsini	3	5	16		
	Austrosimulium	3	5	16		

Prior to the current 2010-2011 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 no 'highly sensitive' taxa; three 'moderately sensitive' taxa (elmid beetles and caddisflies (*Hydrobiosis* and *Pycnocentrodes*)); 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, 2010 community. These comprised one 'highly sensitive', two 'moderately sensitive', and five 'tolerant' taxa, whereas all but two ('tolerant') of these taxa comprised the dominant taxa of the summer, 2011 community. Six of these eight taxa were dominant in both spring and summer communities (Table 71). The relatively similar seasonal dominances were reflected in the small difference (0.5 unit) in seasonal $SQMCI_s$ scores (Tables 156 and 157) which was due mainly to a decreased summer numerical abundance in the 'highly sensitive' mayfly taxon.

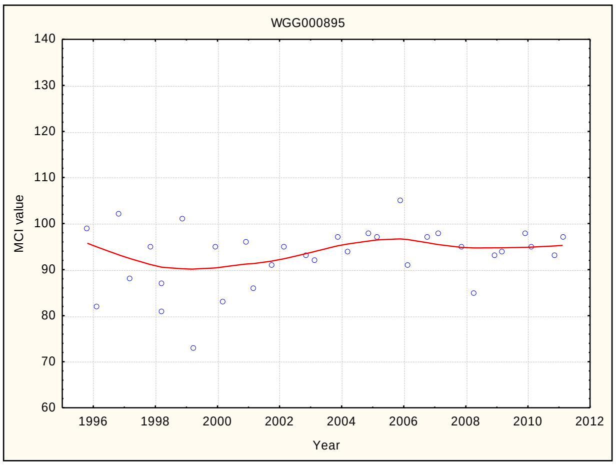
The four taxa recorded as very abundant during spring and/or summer have characterised this site's communities on 45% to 100% of past survey occasions.

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, 2010 survey score (93 units) was 4 units higher than the altitude predictive value and 8 units higher than the predictive distance value while the summer, 2011 score (97 units) was 8 units higher than the predictive altitude value and a significant (Stark, 1998) 12 units above the predicted distance value. Of the 33 surveys to date at this site, 12% of MCI scores have been less than 85 units while 76% have been greater than 89 units.

3.2.16.5.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 33
Kendall tau = +0.155
p value = 0.205 [>FDR, p = 0.328]
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 sixteen 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 bordered on 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

Thirty surveys have been undertaken in the Waingongoro River at this lower reach site at Ohawe Beach between 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000995	30	12-25	18	69-98	88	19	92	16	84

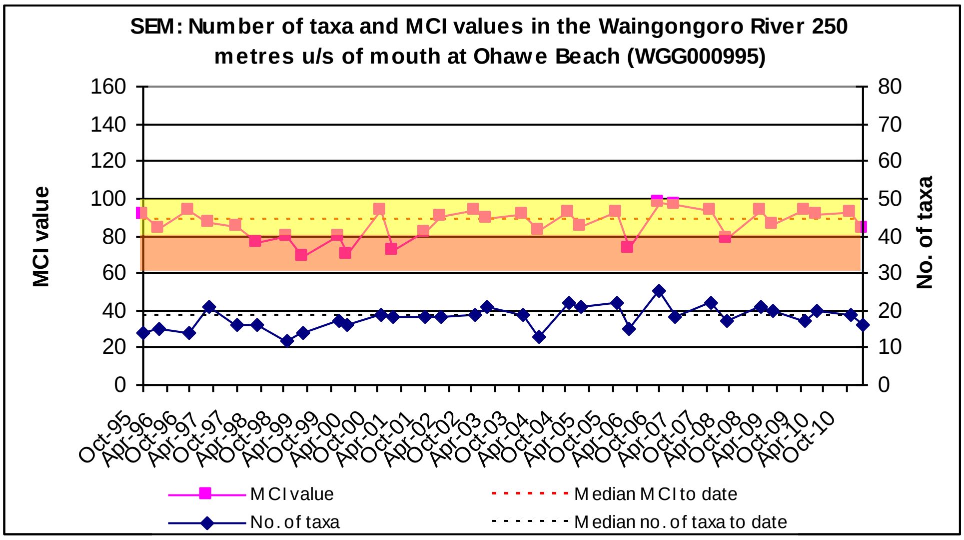


Figure 68 Numbers of taxa and MCI values in the Waingongoro River at the Ohawe Beach site

A wide range of richnesses (12 to 25 taxa) has been found, with a median richness of 18 taxa. During the 2010-2011 period spring (19 taxa) and summer (16 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 (88 units) has been relatively typical of scores at lower reach sites elsewhere on the ringplain (TRC, 1999 (updated, 2011)). The spring, 2010 (92 units) and summer, 2011 (84 units) scores, while typical for such a site and within 4 units of the historical median, showed a typical summer seasonal decrease. 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' (spring) and 'expected' (summer) health for the lower reaches of a ringplain river. The historical median score (88 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 2010-2011 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	21	70	A	A
	Lumbricidae	5	1	3		
MOLLUSCA	*Potamopyrgus*	4	25	83		
CRUSTACEA	*Paratya*	3	2	7		
EPHEMEROPTERA	*Austroclima*	7	2	7		
	Deleatidium	8	4	13	A	
COLEOPTERA	Elmidae	6	21	70	A	
TRICHOPTERA	*Aoteapsyche*	4	29	97	A	A
	Costachorema	7	1	3		
	Hydrobiosis	5	3	10		
	Pycnocentrodes	5	23	77	XA	VA
DIPTERA	*Aphrophila*	5	5	17		
	Maoridiamesa	3	23	77	VA	
	Orthocladiinae	2	28	93	XA	VA
	Tanytarsini	3	5	17		
	Ephydridae	4	2	7		
	Austrosimulium	3	4	13		

Prior to the current 2010-2011 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)). Seven of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive' taxon, two 'moderately sensitive' taxa, and four 'tolerant' taxa, whereas one 'moderately sensitive' and three 'tolerant' taxa comprised the dominant taxa of the summer, 2011 community.
Although only three of these seven taxa were dominant in both spring and summer communities (Table 73), there was a minimal difference (0.1 unit) in seasonal $SQMCI_s$ scores (Tables 156 and 157).

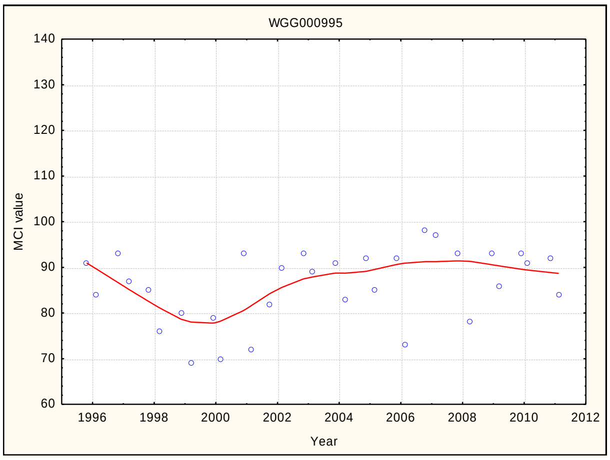
The three taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 77% to 93% of past survey occasions.

3.2.16.6.3 Predicted stream 'health'

The Waingongoro River at the Ohawe Beach site is 66.6km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams and rivers developed between MCI and 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 (88) is 3 units higher than both the altitude and the distance predictive values. The spring, 2010 survey score (92 units) was 7 units higher than both predictive values while the summer score (84 units) was one unit lower than the predictive altitude and distance values. Of the 32 surveys to date at this site, 38% of MCI scores have been less than 85 units while 56% have been greater than 85 units.

3.2.16.6.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.213
p value = 0.087 [>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, which has plateaued since 2007, the overall sixteen-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 scores (<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 border on 'better than expected' over the subsequent six years.

3.2.16.7 Discussion

Seasonal MCI values typically decreased between spring and summer at five of the six sites by 3, 3, 3, 6 and 8 units in a downstream direction with the exception of the SH45 site where there was an atypically small increase (4 units). Seasonal communities shared 60% of the 40 taxa common at the upper site near the National Park, 61% of 31 taxa at the Opunake Road upper mid-reach site, 52% of 25 taxa at the Eltham Road mid-reach site, 75% of 20 taxa at the Stuart Road mid-reach site, 65% of 23 taxa at the SH45 lower reach site, and 59% of 22 taxa at the furthest downstream site (Ohawe Beach) in the lower reaches. Seasonal community compositions therefore did not follow typical trends of generally more variability with increased distance downstream from the National Park in the 2010-2011 period.

Community composition varied markedly through the length of the river surveyed. A total of 48 taxa was recorded in spring of which only five taxa were present at all six sites. These included one 'highly sensitive' taxon, two 'moderately sensitive' taxa, and two 'tolerant' taxon with only the 'highly sensitive' mayfly (*Deleatidium*) and 'moderately sensitive' elmid beetles abundant at all six sites. A lower total of 44 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 to the same as the five widespread taxa in spring with the addition of two 'moderately sensitive' taxa. Only the one 'tolerant' caddisfly was abundant at all six sites. These dissimilarities in spatial community structure along the length of the Waingongoro River were slightly more pronounced in spring than in summer.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 39 units in spring and 44 units in summer, over a river distance of 65.9 km. These seasonal falls in MCI scores equated to rates of decline of 0.6 unit/km (spring) and 0.7 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 (for ringplain streams) 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 (1.2 units/km) and summer (1.2 units/km) rates of decline were slightly 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 (0.25 unit/km) and summer (0.4 unit/km) rates of decline were similar to the predicted rate of 0.3 unit/km. Previously more marked rates of decline had been recorded between the Eltham Road and Stuart Road mid-reach sites (6.6 km reach) in spring and summer compared with the predicted rate (0.5 units/km) for the equivalent reach of this river. This had been attributable to point source discharges of treated Eltham municipal wastes and treated industrial (meatworks) wastes within this reach but since the removal of both discharges (post July 2010) these rates were minimal, (<0.35 unit/km) in spring 2010 and summer 2011.

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 0.16 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 2010-2011 period were slighly lower in both spring and summer for the upper reach and slightly higher (particularly in summer) for the lower reach of the river than have been typical of average rates prior to 2010.

3.2.17 Mangawhero Stream

The results found by the 2010-2011 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)

3.2.17.1.1 Taxa richness and MCI

Thirty surveys have been undertaken in this mid-reach site in the Mangawhero Stream within about 3 km of the Ngaere swamp 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000380	30	10-23	15	58-85	73	16	76	12	77

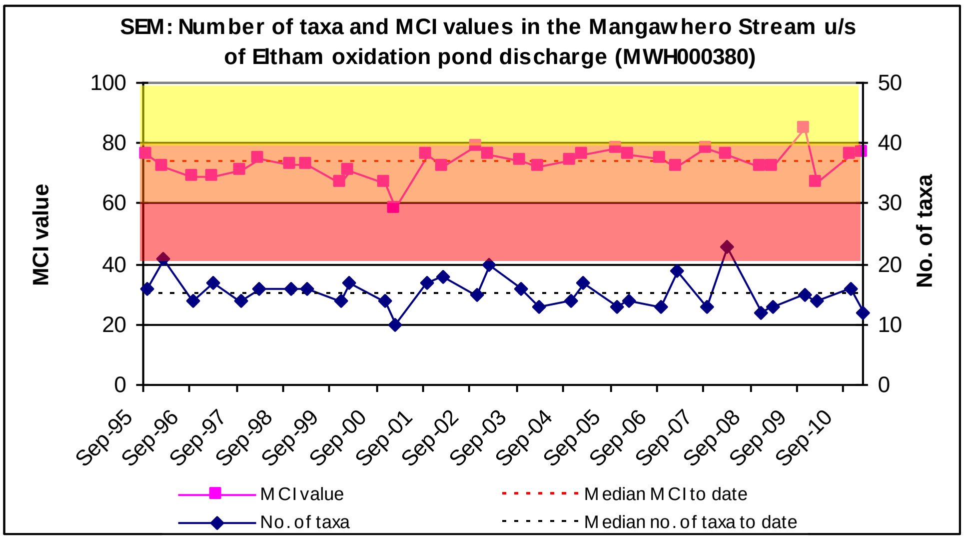


Figure 70 Numbers of taxa and MCI values in the Mangawhero Stream upstream of Eltham WWTP

A moderate range of richnesses (10 to 23 taxa) has been found, with a median richness of 15 taxa (more representative of typical richnesses in small swamp drainage streams where a median richness of 18 taxa has been recorded from 159 previous surveys of 'control' sites at similar altitudes (TRC, 1999 (updated, 2011)). During the 2010-2011 period, spring (16 taxa) and summer (12 taxa) richnesses were within three taxa of this median richness, at a site where the habitat was predominantly comprised of a hard clay substrate and patchy (spring) to widespread (summer) filamentous algal substrate cover.

MCI values have had a moderate range (27 units) at this site. The median value (73 units) has been typical of similar non-rinplain sites elsewhere in the region however, and the very similar spring, 2010 (76 units) and summer, 2011 (77 units) scores were typical of the range for such a site. There were higher by 3 units in spring and 4 units in summer than the historical median. These scores categorised this site as having 'poor' (spring) and 'poor' (summer) health generically (Table 1) and were within 1 to 2 units of the median MCI score (78 units) recorded by 159 previous surveys of similar 'control' sites in small, non ringplain streams in Taranaki (TRC, 1999 (updated, 2011)). 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 in the region.

3.2.17.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	1	3		
ANNELIDA	Oligochaeta	1	19	63	A	
	Lumbricidae	5	1	3		
MOLLUSCA	*Potamopyrgus*	4	2	7		
CRUSTACEA	Ostracoda	1	8	27		
	Paracalliope	5	26	87	A	VA
EPHEMEROPTERA	*Austroclima*	7	27	90	VA	A
TRICHOPTERA	*Aoteapsyche*	4	12	40		
	Hydrobiosis	5	5	17	A	
	Polyplectropus	6	1	3		
	Oxyethira	2	4	13		
DIPTERA	*Aphrophila*	5	14	47	A	
	Chironomus	1	2	7		
	Maoridiamesa	3	7	23	A	
	Orthocladiinae	2	30	100	A	A
	Austrosimulium	3	15	50		

Prior to the current 2010-2011 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 two 'moderately sensitive' taxa (amphipod (*Paracalliope*) and mayfly (*Austroclima*)); and three 'tolerant' taxa (oligochaete worms, sandfly (*Austrosimulium*), and orthoclad midges).

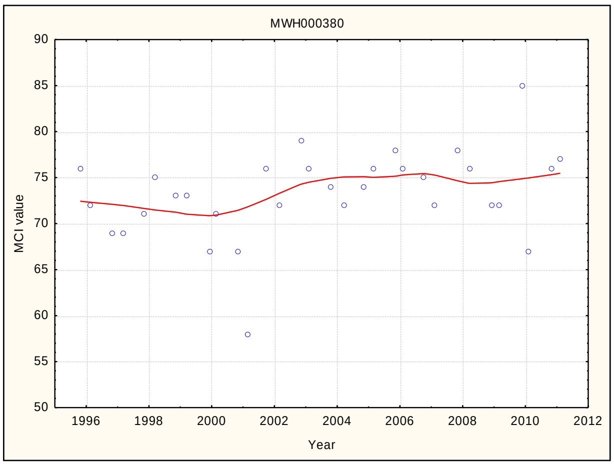
Seven of the historically characteristic taxa were dominant in the spring, 2010 community and comprised four of the predominant taxa (above). The summer, 2011 community was characterised by only three of the taxa dominant in spring, all of which previously had been predominantly characteristic of this site's communities (Table 75). Despite the reduction in number of characteristic summer taxa, only a minor decrease in $SQMCI_s$ scores (0.4 unit) was recorded between seasons (Tables 158 and 159). The two taxa which were recorded as very abundant during spring and/or summer chad characterised this site's communities on 87% of 90% of past surveys.

3.2.17.1.3 Predicted stream 'health'

The Mangawhero Stream rises as seepage from the Ngaere swamp and is not a ringplain stream at the site upstream of the Eltham WWTP 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.

3.2.17.1.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.273
p value = 0.028 [>FDR, p = 0.081]
Significant at p <0.05 level;
N/S after FDR application

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 ($p < 0.05$ after FDR) has been found over the sixteen year monitoring period at this site with the early trend of slightly increasing scores having been followed by a plateauing of scores a few units above those recorded early in the programme. 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

Thirty surveys have been undertaken at this lower reach site in the Mangawhero Stream between 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000490	30	13-25	19	63-86	77	16	90	23	84

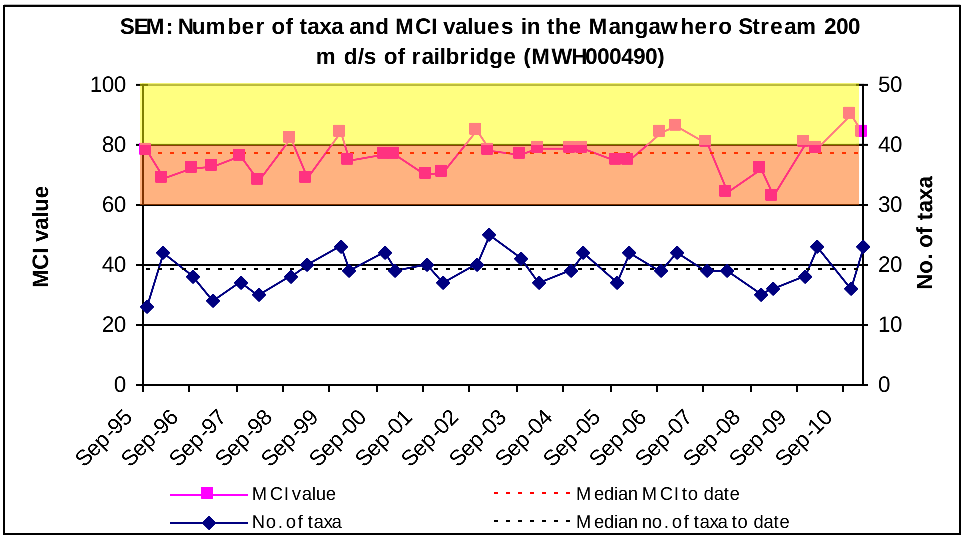


Figure 72 Numbers of taxa and MCI values in the Mangawhero Stream downstream of the railbridge and Mangawharawhara Stream confluence

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 2010-2011 period, spring (16 taxa) and summer (23 taxa) richnesses were quite different but within four taxa of 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 ringplain streams. However, the median value (77 units) has been lower than typical of lower reach sites elsewhere. However the spring, 2010 (90 units) and summer, 2011 (84 units) scores were 7 to a significant (Stark, 1998) 13 units higher than the historical median. These scores were coincident with the diversion of the major point source Eltham municipal wastewater discharge out of the Mangawhero Stream which was completed in June 2010. The spring, 2010 MCI score was 4 units higher than the historical maximum for this site. These scores categorised this site as having 'fair' health generically (Table 1) in spring and summer and, in terms of predictive relationships (Table 2), 'expected' (spring) to 'worse than expected' (summer) health for the equivalent mid-reaches of a stream with some ringplain catchment component (Mangawharawhara Stream which rises outside of the National Park). 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. The historical median score 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, prior to diversion in July, 2010.

3.2.17.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 February 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	30	100	A	VA
MOLLUSCA	*Physa*	3	2	7		
	Potamopyrgus	4	7	23		VA
CRUSTACEA	Cladocera	5	3	10		
	Ostracoda	1	26	87		
	Paracalliope	5	29	97	A	VA
	Paraleptamphopidae	5	2	7		
EPHEMEROPTERA	*Austroclima*	7	1	3		
	Deleatidium	8	1	3	VA	VA
COLEOPTERA	Elmidae	6	2	7		
TRICHOPTERA	*Aoteapsyche*	4	17	57	A	VA
	Hydrobiosis	5	8	27		A
	Oxyethira	2	9	30		
	Pycnocentrodes	5	1	3		
DIPTERA	*Aphrophila*	5	5	17		VA
	Chironomus	1	2	7		
	Maoridiamesa	3	15	50	VA	A
	Orthocladiinae	2	27	90	A	VA
	Tanypodinae	5	1	3		
	Tanytarsini	3	1	3		
	Muscidae	3	1	3		
	Austrosimulium	3	13	43		

Prior to the current 2010-2011 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 five 'tolerant' taxa (oligochaete worms, ostracod seed shrimps, net-building caddisfly (*Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)). Five of these predominant taxa were dominant in the spring, 2010 community together with one of the other historically characteristic taxa ('highly sensitive' mayfly which had only been characteristic of the community on one previous occasion) The summer, 2011 community was characterised by the same taxa dominant in spring, together with three additional taxa; all of which previously had been characteristic of this site's communities (Table 77). The repeated abundance of the 'highly sensitive' mayfly (*Deleatidium*) was further confirmation of improved water quality (and habitat) conditions following Eltham WWTP wastewater diversion. Despite seasonal similarities in characteristic taxa, increased summer abundances within three of the 'tolerant' taxa were reflected in the decrease of 0.7 unit 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 3% to 100 % of the past surveys with three taxa or less than 30% of occasions also indicative of the recent habitat improvements.

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, 2010 (90 units) and summer, 2011 (84 units) scores were also well below this predictive value by 14 and 20 units respectively although it must be noted that the catchment is not entirely of ringplain derivation. Of the 32 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 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen years 1995-2011) 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.

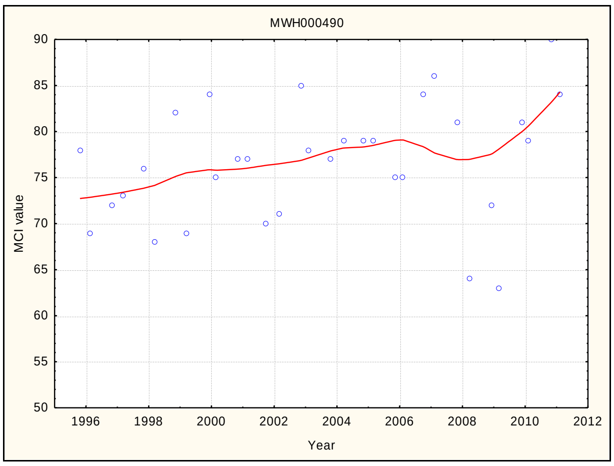


Figure 73 LOWESS trend plot of MCI data at the site downstream of the Mangawharawhara Stream confluence

N = 32
Kendall tau = +0.261
p value = 0.036 [>FDR, p = 0.088]
Significant at p <0.05;
Not significant after FDR

A moderate and recently more pronounced, but not statistically significant (after FDR), 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 (11 units) has marginal ecological significance over this sixteen year period. Scores trended downwards for 3 years after a steady improvement between 1995 and 2006 prior to a very recent marked improvement due to improved scores since the diversion of the Eltham WWTP wastes discharge out of the stream in July 2010.

The MCI scores were generally indicative of 'poor' generic stream health (Table 1) with sporadic incursions into the 'fair' health category particularly recently, although the LOWESS-smoothed scores have remained in the 'poor' category throughout the period until 2010. 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 has been 'worse than expected' throughout the entire sixteen year period, but has approached the 'expected' category in the recent 2010-2011 survey period.

3.2.17.3 Discussion

Seasonal MCI values atypically did not deteriorate between spring and summer at the upper reach (upstream of the Eltham WWTP) with scores almost identical, whereas a more typical decrease (6 units) was found at the lower site (downstream of the Mangawharawhara Stream confluence) despite the absence of the WWTP discharge which had significantly impacted on water quality at this site prior to mid 2010. Seasonal communities at the upper reach site shared 9 common taxa (56% of the 19 taxa found in 2010-2011) compared with 14 shared common taxa (56% of the 25 taxa found in 2010-2011) at the lower site, a less than typical seasonal change in community structure historically found at the lower of the two sites. The two sites shared 11 common taxa (52% of the 21 taxa) in spring and 11 common taxa (46% of 24 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and summer and slightly more so in summer, as might be expected given the significantly different physical and physicochemical habitats at these two sites.

MCI scores typically (for this stream) improved in a downstream direction by 14 units in spring and also increased in summer (by 7 units), over a stream distance of 16.5 km between the upper and lower sites of this stream. This was principally as a result of the variability and improvement in physical habitat and physicochemical water quality conditions in a downstream direction between the two sites.

3.2.18 Huatoki Stream

The results of spring (2010) and summer (2010-2011) 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-eight surveys have been undertaken, between 1996 and March 2010, 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1996 to March 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		March 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000350	28	22-31	26	79-105	94	24	104	28	101

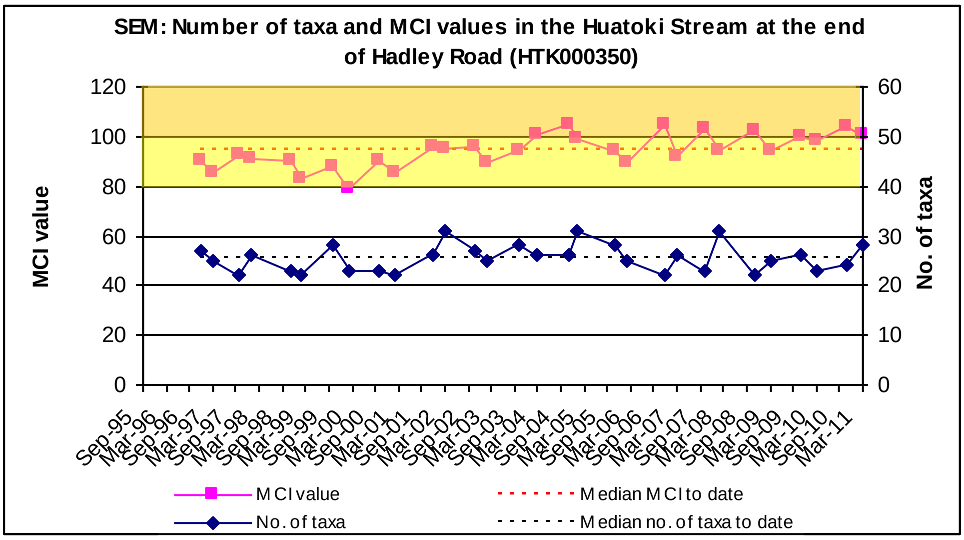


Figure 74 Numbers of taxa and MCI values in the Huatoki Stream at the end of Hadley Drive

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 2010-2011 period spring (24 taxa) and summer (28 taxa) richnesses were within two 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, 2010 (104 units) and summer, 2011 (101 units) scores were 10 units and 7 units above the historical median respectively. They 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 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 2010 [28 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	3	11		
ANNELIDA	Oligochaeta	1	18	64	A	
MOLLUSCA	*Latia*	5	1	4		A
	Potamopyrgus	4	20	71		
CRUSTACEA	*Paracalliope*	5	6	21		
EPHEMEROPTERA	*Austroclima*	7	5	18	A	VA
	Coloburiscus	7	13	46	A	VA
	Deleatidium	8	0	0	A	A
	Nesameletus	9	5	18	A	VA
	Zephlebia group	7	16	57	A	A
PLECOPTERA	*Zelandobius*	5	7	25	A	
	Zelandoperla	8	1	4		
COLEOPTERA	Elmidae	6	6	21	A	VA
MEGALOPTERA	*Archichauliodes*	7	1	4		
TRICHOPTERA	*Aoteapsyche*	4	27	96	A	VA
	Costachorema	7	16	57	A	
	Hydrobiosis	5	19	68		A
	Neurochorema	6	2	7		A
	Oxyethira	2	4	14		
	Pycnocentrodes	5	4	14		
DIPTERA	*Aphrophila*	5	16	57		
	Maoridiamesa	3	15	54	A	
	Orthocladiinae	2	28	100	VA	VA
	Tanytarsini	3	12	43		VA
	Empididae	3	1	4		
	Muscidae	3	5	18		
	Austrosimulium	3	12	43		A

Prior to the current 2010-2011 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 no 'highly sensitive' taxa; four 'moderately sensitive' taxa (mayfly (*Zephlebia* group), free-living caddisflies (*Hydrobiosis* and *Costachorema*), and cranefly (*Aphrophila*)); and six 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (orthoclads, tanytarsids, and *Maoridiamesa*)).

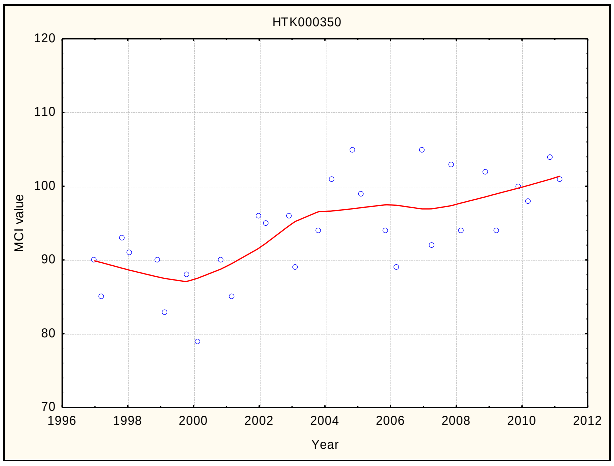
Eleven of the historically characteristic taxa were dominant in the spring, 2010 community comprising six of the predominant taxa (above) together with four of the other historically characteristic taxa and one additional taxon ('highly sensitive' mayfly (*Deleatidium*)) not previously abundant at this site. The summer, 2011 community was characterised by eight 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, but with two fewer 'moderately sensitive' taxa and two 'tolerant' taxa earlier characteristic of the spring community. Increased summer abundances within several 'sensitive' dominant taxa were reflected in the difference in seasonal $SQMCI_s$ scores of 0.7 unit (Table 160 and 161). All taxa which were recorded as very abundant during spring and/or summer had characterised this site's communities on 18% 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 (104 units) and the summer score (101 units) were higher (by 10 to a significant (Stark, 1998) 13 units) than the predictive value. Of the 30 surveys to date at this site, 37% of MCI scores have been less than 91 units, indicating that the current spring and summer MCI scores were higher than those typical of historical conditions.

3.2.18.1.4 Temporal trends in 1996 to 2011 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 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 = 30
Kendall tau = +0.460
p level = 0.0004 [>FDR, p = 0.002]
Significant at p< 0.05
and after FDR application

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

A strong temporal improvement (p< 0.01) in MCI scores, particularly since 2000 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 (14 units) has some ecological significance and may have been related to improvements in farming practices (including most recent riparian fencing) and/or wastes disposal in the rural catchment between the stream's seepage sources (below the National Park) and urban New Plymouth.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) throughout the period bordering on '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 majority of the fifteen year period although it bordered the 'worse than expected' category prior to 2000 and most recently entered 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-eight 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 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1996 to March 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		March 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000425	28	17-32	26	91-115	102	25	109	28	103

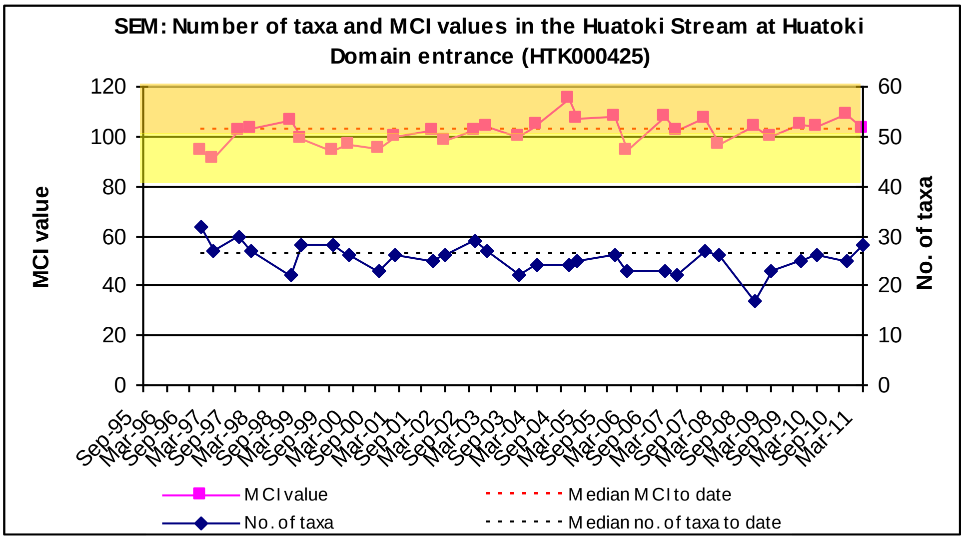


Figure 76 Numbers of taxa and MCI values in the Huatoki Stream at the Huatoki Domain

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 2010-2011 period spring (25 taxa) and summer (28 taxa) richnesses were relatively similar and within two taxa of 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, 2010 (109 units) and summer, 2011 (103 units) scores were also higher than typical for such a site; but insignificantly 7 and 1 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), 'well above expected' (spring) and 'better than expected' (summer) health for the lower reaches of a ringplain stream 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 2010-2011 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 March 2010 [28 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	3	11		
ANNELIDA	Oligochaeta	1	25	89		A
MOLLUSCA	*Latia*	5	15	54		
	Potamopyrgus	4	24	86		VA
CRUSTACEA	*Paracalliope*	5	3	11		
EPHEMEROPTERA	*Austroclima*	7	3	11	A	VA
	Coloburiscus	7	23	82	A	VA
	Deleatidium	8	0	0	VA	A
	Mauiulus	5	1	4		
	Zephlebia group	7	27	96	A	A
PLECOPTERA	*Zelandobius*	5	14	50	VA	
COLEOPTERA	Elmidae	6	17	61	A	VA
	Ptilodactylidae	8	3	11		
MEGALOPTERA	*Archichauliodes*	7	10	36	A	A
TRICHOPTERA	*Aoteapsyche*	4	27	96	A	VA
	Costachorema	7	1	4		
	Hydrobiosis	5	6	21		
	Pycnocentrodes	5	17	61	A	A
DIPTERA	*Aphrophila*	5	1	4		
	Orthocladiinae	2	8	29	A	
	Austrosimulium	3	27	96	A	A
	Tanyderidae	4	1	4		

Prior to the current 2010-2011 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 no 'highly sensitive' taxa; six 'moderately sensitive' taxa (luminescent limpet (*Latia*), mayflies (*Zephlebia* group and *Coloburiscus*), stonefly (*Zelandobius*), elmid beetles, and stony-cased caddisfly (*Pycnocentrodes*)); and four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and sandfly (*Austrosimulium*)).

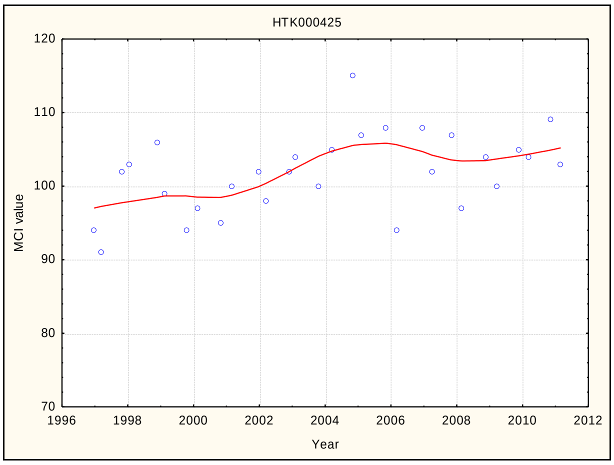
Ten of the historically characteristic taxa were dominant in the spring, 2010 community and comprised seven of the predominant taxa (above) together with two 'moderately sensitive' and one 'tolerant' taxa together with one additional 'highly sensitive' (mayfly) taxon not previously dominant at this site. The summer, 2011 community was characterised by nine of the taxa dominant in spring, together with an additional two 'tolerant' taxa, both of which previously had been characteristic of this site's communities and one fewer 'moderately sensitive' and 'tolerant' taxa than characteristic of the spring community (Table 81). The relative similarity in seasonal dominant taxa was reflected in the small difference in $SQMCI_s$ scores of 0.4 unit (Tables 160 and 161). All taxa which were recorded as very abundant during spring and/or summer had characterised this site's communities on 11% to 96% of past surveys with the exception of the 'highly sensitive' mayfly taxon which was dominant for the first occasion.

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 (109 units) and the summer score (103 units) were significantly higher (Stark, 1998) than the predictive value. Of the 30 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 2011 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 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 = 30
Kendall tau = +0.351
p level = 0.006 [>FDR, p = 0.024]
Significant at p< 0.05;
and 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, but not quite as strong as that found at the upstream site (at Hadley Drive), was identified at this site in the Domain although scores have peaked with a small decrease since 2006 prior to a recent increasing trend. This trend is statistically significant after FDR application (p< 0.05) but 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) and again very recently, further indication of the value of the extensive riparian cover provided by the Huatoki Domain.

3.2.18.3 Site near coast (HTK000745)

3.2.18.3.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken at this lower reach site in the Huatoki Stream between 1996 and March 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1996 to March 2009)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		March 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000745	28	14-27	22	69-99	86	18	101	24	69

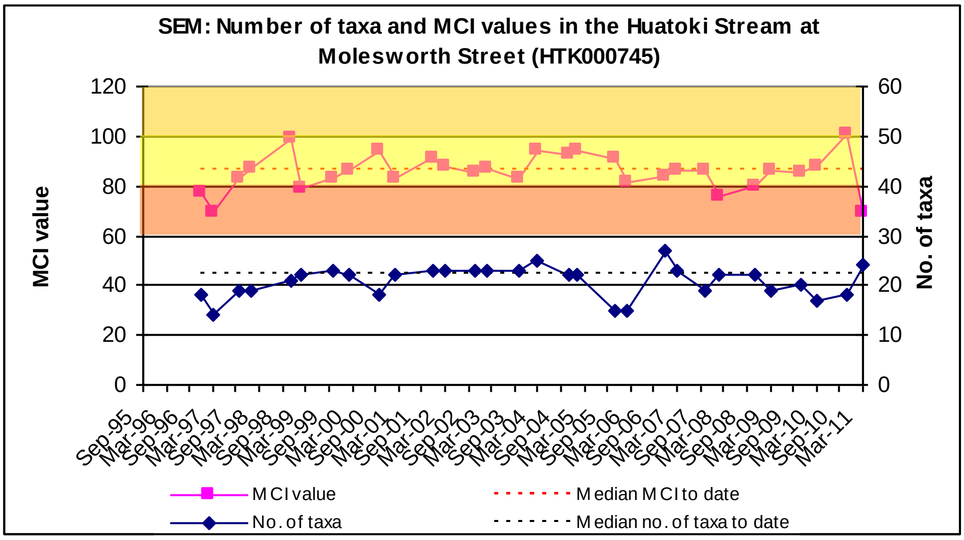


Figure 78 Numbers of taxa and MCI values in the Huatoki Stream at Molesworth Street (near coast)

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 2010-2011 period spring (18 taxa) and summer (24 taxa) richnesses were relatively different and slightly lower in spring and higher in summer 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, 2010 (101 units) and summer, 2011 (69 units) scores varied markedly and were 15 to 17 units either side of the historical median. The spring score was two units higher than the historical maximum score, while the summer score was equivalent with the historical minimum score and coincidental with pulsed flows a short distance downstream of a relatively recently installed weir and fish pass (for beautification purposes). These scores categorised this site as having ‘good’ (spring) and ‘poor’ (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), ‘better than expected’ (spring) and ‘worse than expected’ (summer) health for the lower reaches of a ringplain stream. 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 2010-2011 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 2010 [28 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	1	4		
ANNELIDA	Oligochaeta	1	28	100	VA	XA
MOLLUSCA	*Ferrissia*	3	1	4		
	Latia	5	3	11		
	Potamopyrgus	4	28	100	VA	XA
CRUSTACEA	Ostracoda	1	0	0		A
	Paratya	3	2	7		
EPHEMEROPTERA	*Coloburiscus*	7	4	14		
	Zephlebia group	7	5	18		
PLECOPTERA	*Zelandobius*	5	3	11		
COLEOPTERA	Elmidae	6	12	43	VA	VA
TRICHOPTERA	*Aoteapsyche*	4	3	11		
	Oxyethira	2	1	4		
	Pycnocentrodes	5	8	29		A
	Triplectides	5	2	7		
DIPTERA	*Aphrophila*	5	1	4		
	Orthocladiinae	2	14	50		
	Polypedilum	3	0	0	VA	
	Empididae	3	2	7		
	Austrosimulium	3	1	4		
	Tanyderidae	4	4	14		

Prior to the current 2010-2011 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 no ‘moderately sensitive’ taxa but three ‘tolerant’ taxa (oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges).

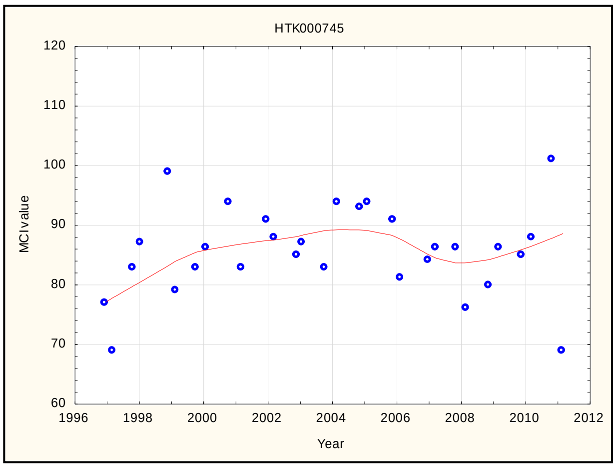
Three of the historically characteristic taxa were dominant in the spring, 2010 community and comprised two of the predominant taxa (above) together with one 'tolerant' (midge) taxon not previously characteristic at this site. The summer, 2010 community was characterised by three of the same taxa dominant in spring, together with an additional 'moderately sensitive' taxon, which previously had been characteristic of this site's communities and one 'tolerant' (ostracods) taxon not previously characteristic at this site (Table 83). Increased numerical summer dominance by two 'tolerant' taxa in particular was reflected in the decrease in $SQMCI_s$ scores of 0.9 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 43% to 100% of past surveys with the exception of the 'tolerant' midge taxon in spring which was dominant for the first occasion.

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 (101 units) was a significant 16 units above, and the summer score (69 units) a significant 16 units below, the predictive value. Of the 30 surveys to date at this site, 40% of MCI scores have been less than 85 units, indicating that the current spring MCI scores was relatively typical of historical conditions.

3.2.18.3.4 Temporal trends in 1996 to 2011 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 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 = 30
Kendall tau = +0.059
p level = 0.648 [>FDR, p = 0.717]
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 before a recent improvement resulting in an overall weakly positive and statistically non-significant trend for the fifteen year monitoring period. However, the range of LOWESS-smoothed scores (12 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 has remained in the 'expected' category approaching 'better than expected' (for a brief two year period from 2003 to 2005).

3.2.18.4 Discussion

Seasonal MCI values typically decreased between spring and summer at all three sites but only by 3 and 6 units respectively at the Hadley Drive and Huatoki Domain sites while at the site near the coast a very significant summer decrease in MCI score (32 units) was recorded. Seasonal communities shared 68% of the 31 taxa common at the mid-reach Hadley Drive site, 66% of 32 taxa at Huatoki Domain, and only 31% of 32 taxa at the furthest downstream site in the lower reaches near the coast indicative of a marked dissimilarity in seasonal community composition at the furthest downstream site where recent upstream modifications have occurred.

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 significant variation 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 2 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 typical of increases recorded by most past surveys. MCI score fell insignificantly by 8 units (spring) and very significantly by 34 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 2.0 and 8.7 units/km respectively. The summer decrease was 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). These MCI rates of decrease were 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 only 3 units (spring) and 32 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 2010-2011 period were similar in spring and much higher in summer than the average rate for the 1995 to 2010 period.

Community composition varied markedly through the mid reach to lower reach length of the stream surveyed. A total of 33 taxa was recorded in spring of which only 13 taxa were present at all three sites. These included three 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa with only the one 'moderately sensitive' taxon (elmid beetles) abundant at all three sites. A much higher total of 47 taxa was found along the stream's surveyed length by the summer survey but only eight taxa were present at all three sites. Six of these were the same as widespread taxa in spring with the addition of one 'moderately sensitive'and one 'tolerant' taxa and loss of all three 'highly sensitive', two 'moderately sensitive', and two 'tolerant' taxa which were widespread in spring. Only one taxon was abundant at all three sites in summer; the 'moderately sensitive' elmid beetles. Dissimilarities in spatial community structure along the surveyed length (mid to lower reaches) of the Huatoki Stream were much less pronounced in spring than 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, 2010 survey are presented in Table 162 and the summer, 2010-2011 survey in Table 163, Appendix I.

3.2.19.1 Opunake Road site (KPK000250)

3.2.19.1.1 Taxa richness and MCI

Twenty-three surveys have been undertaken in the Kaupokohui River at this upper mid-reach site at Opunake Road (draining relatively open farmland approximately 3.3 km downstream of the National Park) between 1999 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1996 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000250	23	20-36	27	125-138	129	25	131	27	133

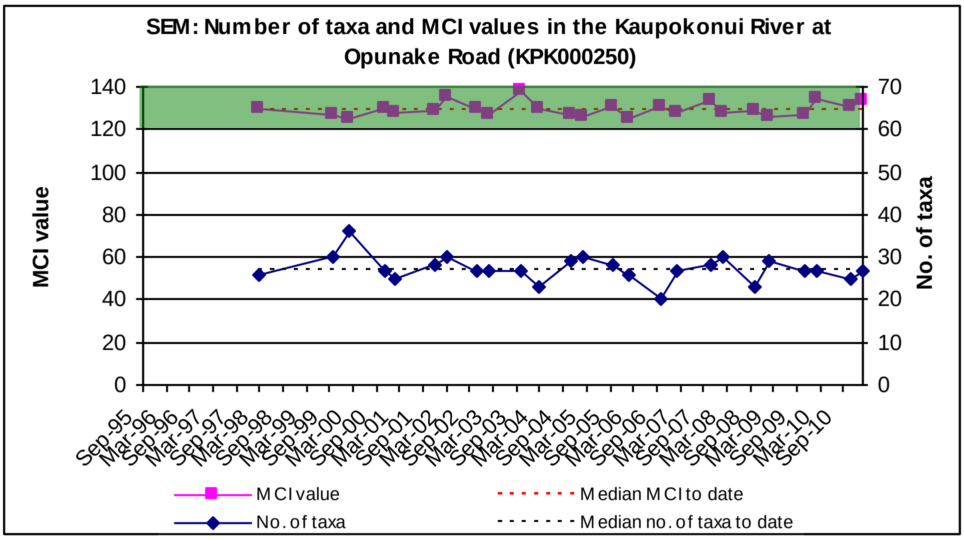


Figure 80 Numbers of taxa and MCI values in the Kaupokonui River at Opunake Road

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 2010-2011 period spring (25 taxa) and summer (27 taxa) richnesses were similar and slightly below to equivalent with median taxa number 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, 2010 (131 units) and summer, 2011 (133 units) scores above those typical for such a site and within 4 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.

3.2.19.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 2010 [23 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	2	9		
EPHEMEROPTERA	*Austroclima*	7	2	9		
	Coloburiscus	7	21	91	A	A
	Deleatidium	8	23	100	VA	XA
	Nesameletus	9	11	48		VA
PLECOPTERA	*Acroperla*	5	1	4		
	Megaleptoperla	9	16	70		A
	Zelandoperla	8	21	91	A	VA
COLEOPTERA	Elmidae	6	23	100	A	VA
	Hydraenidae	8	3	13		
MEGALOPTERA	*Archichauliodes*	7	6	26		
TRICHOPTERA	*Aoteapsyche*	4	19	83		A
	Costachorema	7	5	22		
	Hydrobiosis	5	4	17		
	Beraeoptera	8	16	70	VA	A
	Helicopsyche	10	3	13		
	Olinga	9	14	61		
	Pycnocentrodes	5	11	48		
DIPTERA	*Aphrophila*	5	21	91	VA	VA
	Eriopterini	5	6	26		
	Maoridiamesa	3	7	30		
	Orthocladiinae	2	7	30		

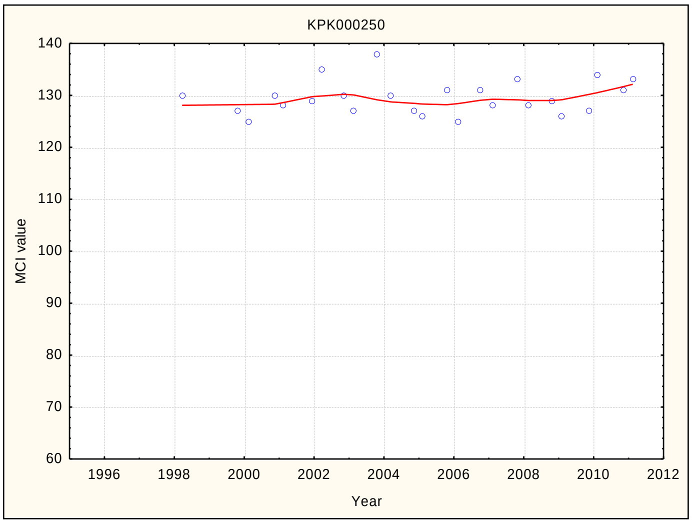
Prior to the current 2010-2011 period, 22 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', ten 'moderately sensitive', and four 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected in the upper mid-reaches of a ringplain stream. Predominant taxa have included five 'highly sensitive' taxa (mayfly (*Deleatidium*, on every sampling occasion), stoneflies (*Megaleptoperla* and *Zelandoperla*), and cased caddisflies (*Beraeoptera* and *Olinga*)); four 'moderately sensitive' taxa (mayfly (*Austroclima*), elmid beetles, and cranefly (*Aphrophila*)); and one 'tolerant' taxon (net-building caddisfly (*Aoteapsyche*)). Six of the predominant taxa were dominant in the spring, 2010 community. These were comprised of three 'highly sensitive', and three 'moderately sensitive', taxa. All of these taxa were again dominant in the summer, 2011 community together with another two 'highly sensitive' and one 'tolerant' taxa. Increased numerical dominance amongst several 'sensitive' taxa in the summer community, was reflected in the small increase in seasonal $SQMCI_s$ values which differed by 0.6 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 48% 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.

3.2.19.1.3 Predicted stream 'health'

The Kaupokonui River site at Opunake Road is 3.3 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and 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, 2010 survey score (131 units) was 8 units to a significantly 13 units higher than these predictive values, whereas the summer, 2011 score (133 units) was higher than both predictive values by 10 to a significant 15 units. Of the 25 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 within 3.5 km of the National Park.

3.2.19.1.4 Temporal trends in 1995 to 2011 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 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 = 25
Kendall tau = +0.118
p level = 0.409 [>FDR, p = 0.507]
N/S at p< 0.05

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

No statistically significant temporal trend of a small improvement in MCI scores was found at this site in the upper mid-reaches of the river over the twelve year monitoring period. The LOWESS-smoothed range of scores (4 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)

3.2.19.2.1 Taxa richness and MCI

Twenty-six 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 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1996 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000500	26	21-33	26	98-126	115	25	133	27	116

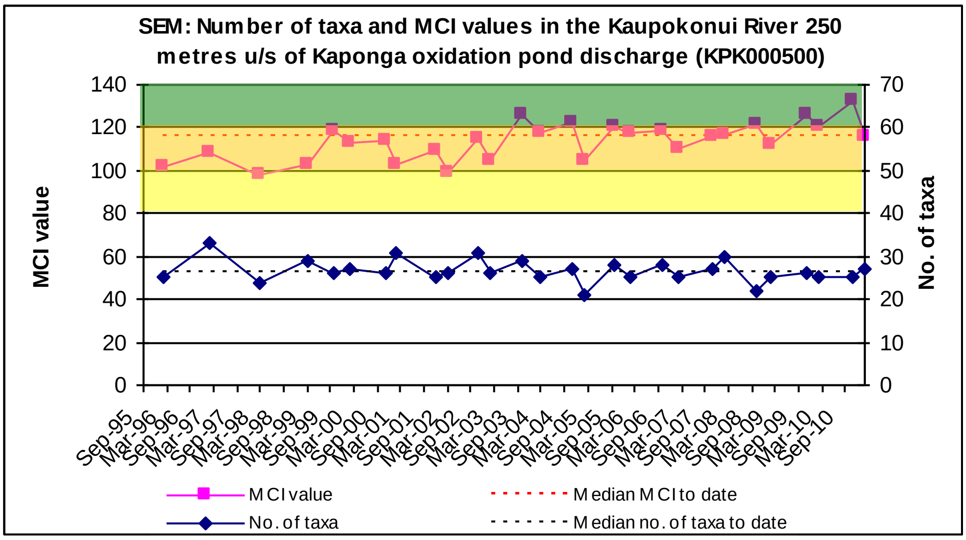


Figure 82 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kaponga oxidation pond system

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 2010-2011 period, spring (25 taxa) and summer (27 taxa) richnesses were 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 (115 units) has been slightly higher than typical of mid-reach sites elsewhere on the ringplain with the spring, 2010 (133 units) and summer, 2011 (116 units) scores with the range typical for such a site and higher than the historical median by 1 to a significant 18 units. 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' and 'better than expected' health in spring and summer respectively for the mid-reaches of a ringplain river. The historical median score (115 units) placed this site in the 'good' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.19.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 2010 [26 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	2	8		
ANNELIDA	Oligochaeta	1	6	23		
EPHEMEROPTERA	*Austroclima*	7	1	4		
	Coloburiscus	7	25	96	VA	VA
	Deleatidium	8	21	81	XA	XA
	Nesameletus	9	9	35	A	VA
PLECOPTERA	*Megaleptoperla*	9	1	4		
	Zelandoperla	8	6	23		
COLEOPTERA	Elmidae	6	23	88	VA	VA
MEGALOPTERA	*Archichauliodes*	7	14	54		
TRICHOPTERA	*Aoteapsyche*	4	22	85	A	VA
	Costachorema	7	17	65		
	Hydrobiosis	5	8	31		
	Beraeoptera	8	10	38	XA	VA
	Olinga	9	3	12		
	Oxyethira	2	1	4		
	Pycnocentrodes	5	12	46	VA	A
DIPTERA	*Aphrophila*	5	25	96	A	VA
	Eriopterini	5	4	15		
	Maoridiamesa	3	20	77		
	Orthocladiinae	2	19	73		
	Tanytarsini	3	5	19		
	Empididae	3	1	4		
	Muscidae	3	3	12		
	Austrosimulium	3	1	4		

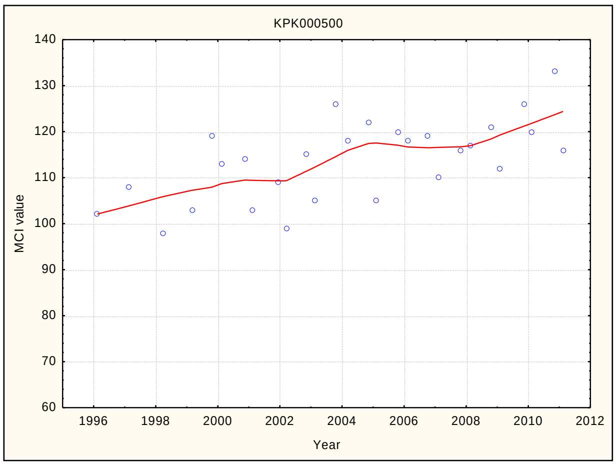
Prior to the current 2010-2011 period, 25 taxa had characterised the community at this site on occasions. These have comprised six 'highly sensitive', nine 'moderately sensitive', and ten 'tolerant' taxa i.e. a majority of 'sensitive' taxa but a small downstream increase in 'tolerant' taxa compared with the Opunake Road site, as would be expected in the mid-reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); five 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Costachorema*), and cranefly (*Aphrophila*)); and three 'tolerant' taxa (free-living caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)). Eight of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised three 'highly sensitive' taxa, four 'moderately sensitive' taxa, and one 'tolerant' taxon, with the identical taxa dominant in the summer community (Table 87). Despite relatively similar seasonal dominances, there was a small decrease (0.4 unit) in $SQMCI_s$ scores between spring and summer principally due to a decreased numerical abundance in one of the 'highly sensitive' taxa in summer (Tables 162 and 163). The eight taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 35% 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 (115) is 4 units higher than the altitude prediction and 8 units higher than the distance predictive value. The spring, 2010 survey score (133 units) was significantly 22 to 26 units above predictive values and the summer, 2011 score (116 units) was 5 units above the predictive altitude value and 9 units above the predictive distance value. Of the 28 surveys to date at this site, 25% of MCI scores have been less than 107 units while 64% have been greater than 111 units.

3.2.19.2.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 28
Kendall tau = +0.441
p level = 0.001 [>FDR, p = 0.006]
Significant at $p < 0.05$ & $p < 0.01$ after FDR application

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

A very strong positive temporal trend in MCI scores has been found over the sixteen-year period which has been statistically significant at the 5% and after FDR application. This has been more pronounced since 2001 but scores plateaued for about three years before a more recent gradual improvement. The wide range of LOWESS-smoothed range of scores (22 units) has ecological significance over the sixteen 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 first fifteen years of the period trending recently into the 'well above expected' category.

3.2.19.3 Site upstream of Kapuni railbridge (KPK000660)

3.2.19.3.1 Taxa richness and MCI

Thirty surveys have been undertaken in the Kaupokonui River at this mid-reach site upstream of the Kapuni railbridge between 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1996 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000660	30	15-32	24	71-122	100	22	107	27	110

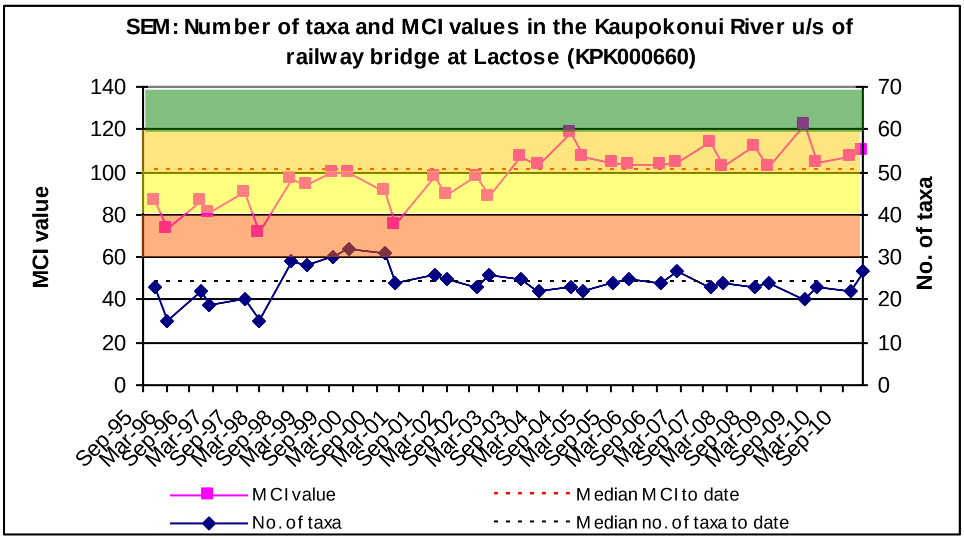


Figure 84 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kapuni railbridge

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 2010-2011 period spring (22 taxa) and summer (27 taxa) richnesses were relatively dissimilar but within three taxa of the median taxa number when more extensive substrate periphyton cover was recorded in summer.

MCI values have had a very wide range (51 units) at this site, wider than typical of sites in the mid reaches of ringplain rivers. However, the median value (100 units) has been typical of mid reach sites elsewhere on the ringplain. The spring, 2010 (107 units) and summer, 2011 (110 units) scores were higher than typical of this site on both occasions. 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' in spring and summer for the mid reaches of a ringplain river. The historical median score (100 units) placed this site in the 'good' 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 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	8	27		
ANNELIDA	Oligochaeta	1	18	60		
	Lumbricidae	5	1	3		
MOLLUSCA	*Potamopyrgus*	4	4	13		A
CRUSTACEA	Ostracoda	1	1	3		
EPHEMEROPTERA	*Austroclima*	7	1	3		A
	Coloburiscus	7	12	40	VA	VA
	Deleatidium	8	19	63	XA	XA
PLECOPTERA	*Acroperla*	5	1	3		
HEMIPTERA	*Sigara*	3	1	3		
COLEOPTERA	Elmidae	6	23	77	VA	XA
	Hydraenidae	8	1	3		
MEGALOPTERA	*Archichauliodes*	7	12	40		A
TRICHOPTERA	*Aoteapsyche*	4	15	50		XA
	Costachorema	7	4	13		
	Hydrobiosis	5	14	47		
	Beraeoptera	8	1	3	A	
	Olinga	9	0	0		A
	Oxyethira	2	6	20		
	Pycnocentrodes	5	6	20	VA	
DIPTERA	*Aphrophila*	5	16	53		A
	Eriopterini	5	1	3		
	Chironomus	1	1	3		
	Maoridiamesa	3	19	63	A	
	Orthocladiinae	2	27	90	A	
	Tanytarsini	3	4	13		
	Empididae	3	2	7		
	Muscidae	3	2	7		
	Austrosimulium	3	5	17		

Prior to the current 2010-2011 period, 28 taxa had characterised the community at this site on occasions. These have comprised three ‘highly sensitive’, eleven ‘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*)); two ‘moderately sensitive’ taxa (elmid beetles and cranefly (*Aphrophila*)); and four ‘tolerant’ taxa (oligochaete worms, free-living caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)). Seven of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised two ‘highly sensitive’ taxa, three ‘moderately sensitive’ taxa, and two ‘tolerant’ taxa.

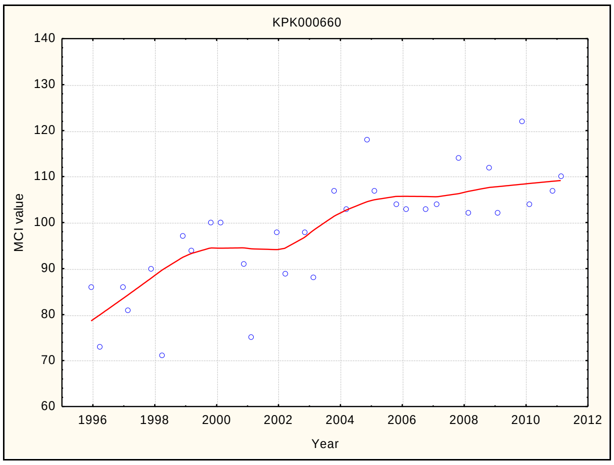
One 'highly sensitive', five 'moderately sensitive', and two 'tolerant' taxa together with an additional one 'highly sensitive' taxon not previously recorded in abundance on any occasion comprised the dominant taxa of the summer community. Only three of these twelve taxa were dominant in both spring and summer communities (Table 89) . An increased abundance in summer within one 'tolerant' taxon (caddisfly) in particular was reflected in the small decrease (0.8 unit) in summer seasonal $SQMCI_s$ score (Tables 162 and 163). The five taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 20% to 77% of past survey occasions.

3.2.19.3.3 Predicted stream 'health'

The Kaupokonui River site upstream of the Kapuni railbridge is 15.5 km downstream of the National Park boundary at an altitude of 170 m asl. Relationships for ringplain streams developed between MCI and 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 (100) is only two units lower than the altitude prediction and one unit lower than the distance predictive value. The spring, 2010 survey score (107 units) was slightly higher than both predictive values and the summer, 2011 score (110 units) was higher than both predictive values by 8 to 9 units. Of the 32 surveys to date at this site, 50% of MCI scores have been less than 101 units while 44% have been greater than 102 units.

3.2.19.3.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.603
p level < 0.0001 [>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 been 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 (30 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)

3.2.19.4.1 Taxa richness and MCI

Thirty surveys have been undertaken in the Kaupokonui River at this lower reach site at Upper Glenn Road between 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1996 to Feb 2010)						2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000880	30	14-31	19	66-101	90	19	108	19	104

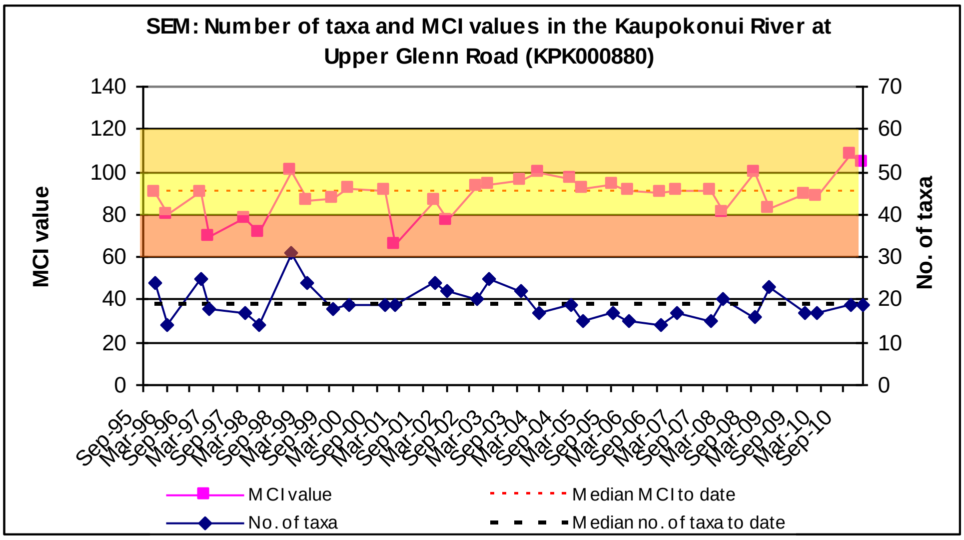


Figure 86 Numbers of taxa and MCI values in Kaupokonui River at Upper Glenn Road

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 2010-2011 period spring (19 taxa) and summer (19 taxa) richnesses were identical and equivalent to the 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 (90 units) has been typical of scores at lower reach sites elsewhere on the ringplain (TRC, 1999 (updated, 2011)), however. The spring, 2010 (108 units) and summer, 2011 (104 units) scores were similar and 3 to 7 units higher than the historical maximum score at this site, and were significantly higher than the historical median. These scores categorised this site has having 'good' health generically (Table 1) on both occasions and, in terms of predictive relationships (Table 2), 'well above expected' (spring) and 'better than expected (summer) health for the lower reaches of a ringplain river. The historical median score (90 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 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
PLATYHELMINTHES	*Cura*	3	1	3		
NEMERTEA	Nemertea	3	5	17		
ANNELIDA	Oligochaeta	1	27	90	A	
MOLLUSCA	*Latia*	5	1	3		
	Physa	3	2	7		
	Potamopyrgus	4	10	33		
CRUSTACEA	Ostracoda	1	1	3		
	Paracalliope	5	1	3		
EPHEMEROPTERA	*Coloburiscus*	7	2	7		
	Deleatidium	8	13	43	A	VA
	Nesameletus	9	1	3		
COLEOPTERA	Elmidae	6	23	77	A	A
MEGALOPTERA	*Archichauliodes*	7	2	7		
TRICHOPTERA	*Aoteapsyche*	4	18	60	A	VA
	Costachorema	7	2	7		
	Hydrobiosis	5	18	60		
	Oxyethira	2	6	20		
	Pycnocentrodes	5	11	37	VA	
DIPTERA	*Aphrophila*	5	5	17		
	Chironomus	1	1	3		
	Maoridiamesa	3	18	60	VA	
	Orthocladiinae	2	28	93	A	A
	Tanytarsini	3	5	17		
	Ephydridae	4	1	3		
	Muscidae	3	2	7		
	Austrosimulium	3	2	7		

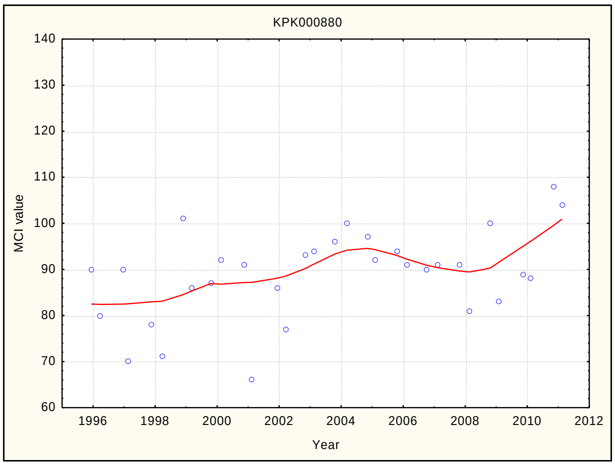
Prior to the current 2010-2011 period, 26 taxa had characterised the community at this site on occasions. These have comprised two 'highly sensitive', nine 'moderately sensitive', and fifteen 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included no 'highly sensitive' taxa; two 'moderately sensitive' taxa (elmid beetles and caddisfly (*Hydrobiosis*); and four 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)). Seven of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive', two 'moderately sensitive', and four 'tolerant' taxa, whereas only four of these taxa (one 'highly sensitive', one 'moderately sensitive', and two 'tolerant' taxa) comprised the dominant taxa of the summer, 2011 community. Five of these seven taxa were dominant in both spring and summer communities (Table 91). The proportional increase in summer dominance by 'sensitive' taxa in particular and absence of one 'tolerant' midge taxon were reflected in the significant increase of 1.3 units in seasonal $SQMCI_s$ scores (Tables 162 and 163). The four taxa recorded as very abundant during spring and/or summer have characterised this site's communities on 37% to 60% 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 (90) is one unit lower than the altitude prediction and five units lower than the predictive distance value. The spring, 2010 score (108 units) and summer, 2011 score (104 units) were 9 to 17 units above both predictive values. Of the 32 surveys to date at this site, 53% of MCI scores have been less than 91 units while only 22% have been greater than 95 units.

3.2.19.4.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 32
Kendall tau = +0.264
p level = 0.034 [>FDR, p = 0.088]
Significant at p < 0.05;
N/S after FDR application

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, before a more recent improvement, but the overall trend had not been statistically significant (p< 0.05 after FDR). The LOWESS-smoothed range of MCI scores (17 units) has been ecologically significant but 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, approaching 'good' health very recently, 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 2003) to 'better than expected' where it has remained despite bordering on 'expected' between 2007 and 2009.

3.2.19.5 Kaupokonui Beach site (KPK000990)

3.2.19.5.1 Taxa richness and MCI

Twenty-two surveys have been undertaken in the Kapokonui River at this lower reach site at Kaupokonui Beach between 1999 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1999 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000990	22	11-26	19	69-98	89	23	94	18	93

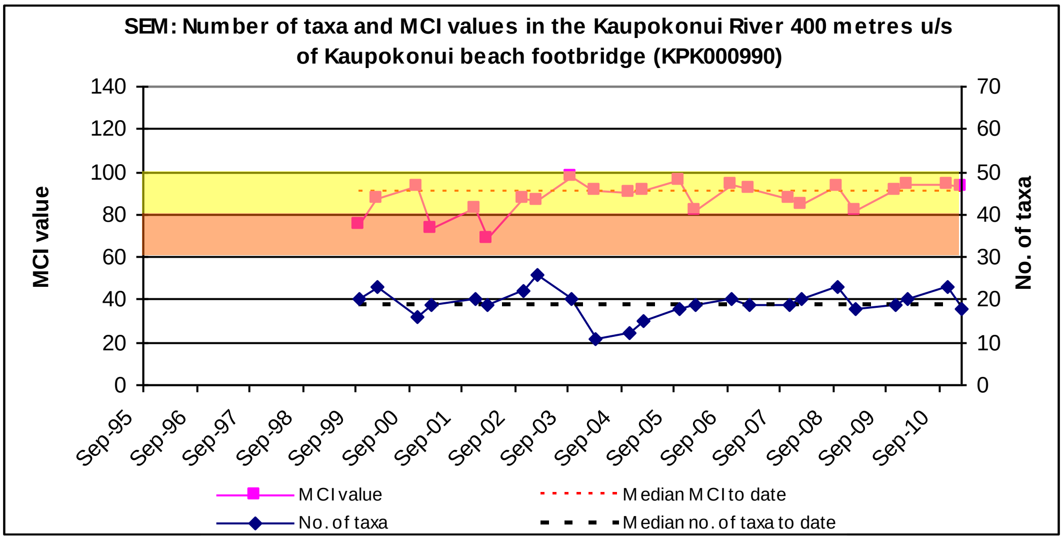


Figure 88 Numbers of taxa and MCI values in the Kaupokonui River at the Kaupokonui Beach site

A wide range of richnesses (11 to 26 taxa) has been found, with a median richness of 19 taxa. During the 2010-2011 period spring (23 taxa) and summer (18 taxa) richnesses were dissimilar but within four 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 (89 units) has been relatively typical of scores at lower reach sites elsewhere on the ringplain (TRC, 1999 (updated, 2011)). The spring, 2010 (94 units) and summer, 2011 (93 units) scores were very similar and also typical for such a site and within 5 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 (89 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 2010-2011 period are listed in Table 93.

Prior to the current 2010-2011 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 five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)).

Table 93 Characteristic taxa (abundant, very abundant,, extremely abundant) recorded in the Kaupokonui River at the Kaupokonui Beach site between 1999 and February 2010 [22 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	3	14		
ANNELIDA	Oligochaeta	1	21	95	VA	VA
MOLLUSCA	*Potamopyrgus*	4	11	50		
EPHEMEROPTERA	*Austroclima*	7	1	5		
	Deleatidium	8	14	64	VA	A
COLEOPTERA	Elmidae	6	17	77	VA	
TRICHOPTERA	*Aoteapsyche*	4	14	64		A
	Costachorema	7	3	14		
	Hydrobiosis	5	16	73	A	
	Pycnocentrodes	5	12	55	XA	VA
DIPTERA	*Aphrophila*	5	1	5		
	Maoridiamesa	3	15	68	VA	
	Orthocladiinae	2	21	95	A	A
	Tanytarsini	3	6	27		A
	Muscidae	3	1	5		

Seven of the historically characteristic taxa were dominant in the spring, 2010 community. These comprised one 'highly sensitive' taxon, three 'moderately sensitive' taxa, and three 'tolerant' taxa, whereas one 'highly sensitive', one 'moderately sensitive', and four 'tolerant' taxa comprised the dominant taxa of the summer, 2011 community. Four of these nine taxa were dominant in both spring and summer communities (Table 93) but decreased numerical abundances in two 'sensitive' taxa and the loss of two 'moderately sensitive' taxa was reflected in the significant summer decrease of (1.3 units) in $SQMCI_s$ score (Tables 162 and 163).

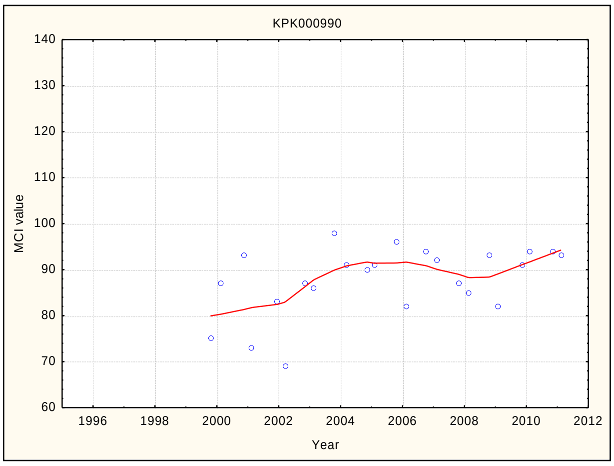
The five taxa recorded as very or extrememly abundant during spring and/or summer have characterised this site's communities on 55% to 95% of past survey occasions.

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 (89) is 4 units higher than the altitude and 4 units below the distance predictive values. The spring 2010 survey score (94 units) was within 9 units of both predictive values while the summer score (93 units) was 8 units higher than the predictive altitude value and equal with the distance value. Of the 24 surveys to date at this site, 25% of MCI scores have been less than 85 units while only 21% have been greater than 93 units.

3.2.19.5.4 Temporal trends in 1999 to 2011 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 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 = 24
Kendall tau = +0.301
p level = 0.039 [>FDR, p = 0.094]
Significant at $p < 0.05$;
N/S after FDR

Figure 89 LOWESS trend plot of MCI data at the Kaupokonui Beach site

Although the twelve year trend in MCI scores has indicated some improvement, the overall temporal trend has not been statistically significant ($p< 0.05$ after FDR). However, an ecologically significant range of LOWESS-smoothed scores (14 units) has been recorded, much narrower than ranges at the two nearest upstream sites, 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 majority of the subsequent eight years.

3.2.19.6 Discussion

Seasonal MCI values typically decreased between spring and summer at the Kaponga WWTP site below the Opunake Road site (which increased by 2 units) by 17 units prior to a small atypical increase (of 3 units) at the Kapuni railbridge site and decreases of 4 units at the Upper Glenn Road and 1 unit at the Kaupokonui Beach site. Seasonal communities shared 73% of 30 taxa at the Opunake Road upper mid-reach site, 63% of 32 taxa at the Kaponga mid-reach site, 63% of 30 taxa at the Kapuni Railbridge mid-reach site, 58% of 24 taxa at the Upper Glenn Road lower reach site, and 46% of 28 taxa at the furthest downstream site (Kaupokonui Beach) in the lower reaches. Seasonal community compositions were generally more variable with increasing distance downstream from the National Park, particularly nearer the coast.

Community composition varied markedly through the length of the river surveyed. A total of 38 taxa was recorded in spring of which only ten taxa were present at all five sites. These included one 'highly sensitive' taxon, six 'moderately sensitive' taxa, and three 'tolerant' taxa with only the 'highly sensitive' mayfly (*Deleatidium*) and 'moderately sensitive' elmid beetles abundant at all five sites. A very similar total of 39 taxa was found along the river's length by the summer survey of which nine taxa were present at all five sites. These were very similar to the ten widespread taxa in spring with the overall loss of one 'tolerant' taxon. Only the one 'highly sensitive' mayfly and one 'tolerant' net-building caddisfly were 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 37 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 16 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 (3.0 units/km) and summer (2.9 units/km) rates of decline were very similar and much higher than 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 (0.8 unit/km) and summer (1.0 unit/km) rates of decline were similar with both rates 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 2.3 and 0.6 units per km respectively with an overall rate of decline of 1.3 MCI units/km over the river's length. Therefore overall rates of decline over the 2010-2011 period were very similar in both spring and summer to the average rate prior to 2011.

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 2008-2009 period severe headwater erosion events impacted upon the macroinvertebrate communities of the upper reaches of this stream (TRC, 2009). The results found in the 2010-2011 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-two surveys have been undertaken at this upper reach site in the Katikara Stream inside the National park boundary at Carrington Road between 1999 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to February 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Mar 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KTK000150	22	11-38	31	112-148	138	23	135	15	133

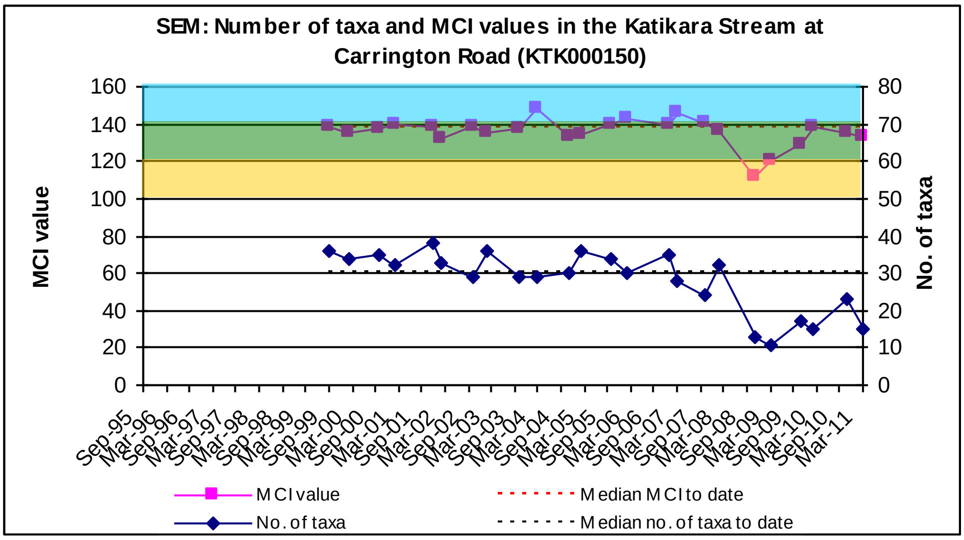


Figure 90 Numbers of taxa and MCI values in the Katikara Stream at Carrington Road

A very wide range of richnesses (11 to 38 taxa) has been found; wider than might be expected, due to headwater erosion effects over the 2008-2009 period, with a median richness of 31 taxa (far more representative of typical richnesses in ringplain streams and rivers near the National Park boundary). During the 2010-2011 period spring (23 taxa) and summer (15 taxa) richnesses were well below this median richness indicative of a continuing post-headwater erosion recovery phase and/or long term degradation of the physical habitat.

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, 2010 (135 units) and summer, 2010 (133 units) scores were relatively typical for such a site, but 3 to 5 units lower than the historical median. These scores categorised this site as having 'very good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected to 'expected' health for the upper reaches of a ringplain stream on spring and summer occasions respectively although taxa richnesses were not indicative of typical pre-erosion community compositions. 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.

3.2.20.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 March 2010 [22 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
EPHEMEROPTERA	*Ameletopsis*	10	1	5		
	Austroclima	7	15	68		
	Coloburiscus	7	18	82		A
	Deleatidium	8	19	86	VA	A
	Nesameletus	9	14	64	A	A
PLECOPTERA	*Acroperla*	5	2	9		
	Austroperla	9	6	27		
	Zelandobius	5	18	82		
	Zelandoperla	8	9	41	VA	VA
COLEOPTERA	Elmidae	6	7	32		
MEGALOPTERA	*Archichauliodes*	7	0	0		A
TRICHOPTERA	*Costachorema*	7	1	5		
	Hydrobiosis	5	1	5		
	Hydrobiosella	9	7	32		
	Orthopsyche	9	8	36		
	Beraeoptera	8	1	5		
DIPTERA	*Aphrophila*	5	5	23		
	Orthocladiinae	2	14	64		
	Polypedilum	3	0	0		A

Prior to the current 2010-2011 period, 17 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', eight '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 two 'highly sensitive' taxa (mayflies (*Deleatidium* and *Nesameletus*)); three 'moderately sensitive' taxa (mayflies (*Coloburiscus* and *Austroclima*), and stonefly (*Zelandobius*)); and one 'tolerant' taxon (orthoclad midges).

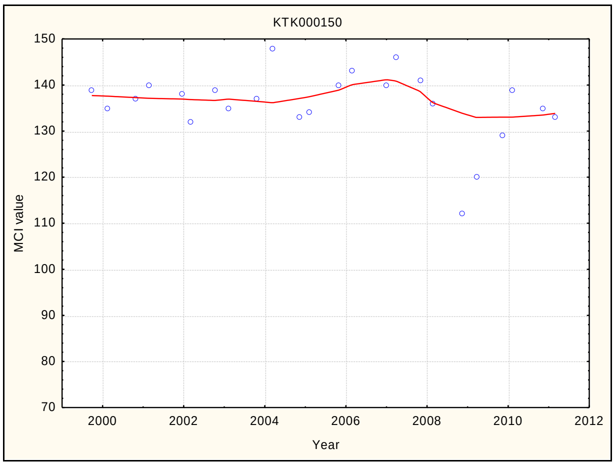
Three of the characteristic taxa (all 'highly sensitive' taxa) were dominant in the spring, 2010 community. All of these three taxa were again dominant in the summer, 2011 community together with two 'moderately sensitive' historically characteristic taxa of this site (mayfly and dobsonfly) and another 'tolerant' midge taxon 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 similarities in seasonal characteristic community compositions were reflected in the minimal summer decrease of 0.4 unit in $SQMCI_s$ values (Tables 164 and 165). The two taxa recorded as very abundant at the time of the spring survey had characterised this site's communities on 41% to 86% 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 (135 units) and summer (133 units) scores were within 8 units and 6 units respectively of both predictive values. Of the 24 surveys to date at this site, only 8% of MCI scores have been less than 127 units while 88% have been greater than 132 units.

3.2.20.1.4 Temporal trends in 1999 to 2011 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 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 = 24
Kendall tau = -0.129
p level = 0.376 [>FDR, p = 0.476]
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 of deterioration has not been statistically significant and the range of LOWESS-smoothed scores (8 units) over the period has not 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 then just dropping into the 'expected' category since the headwater erosion impacts during 2008.

3.2.20.2 Coastal site (KTK000248)

3.2.20.2.1 Taxa richness and MCI

Twenty-one surveys have been undertaken in the Katikara Stream at this lower reach site near the coast between 2000 and February 2010. 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 together with spring 2010 and summer 2011

Site code	SEM data (1995 to February 2010)						2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2009		Mar 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KTK000248	21	20-31	25	81-116	103	26	102	27	101

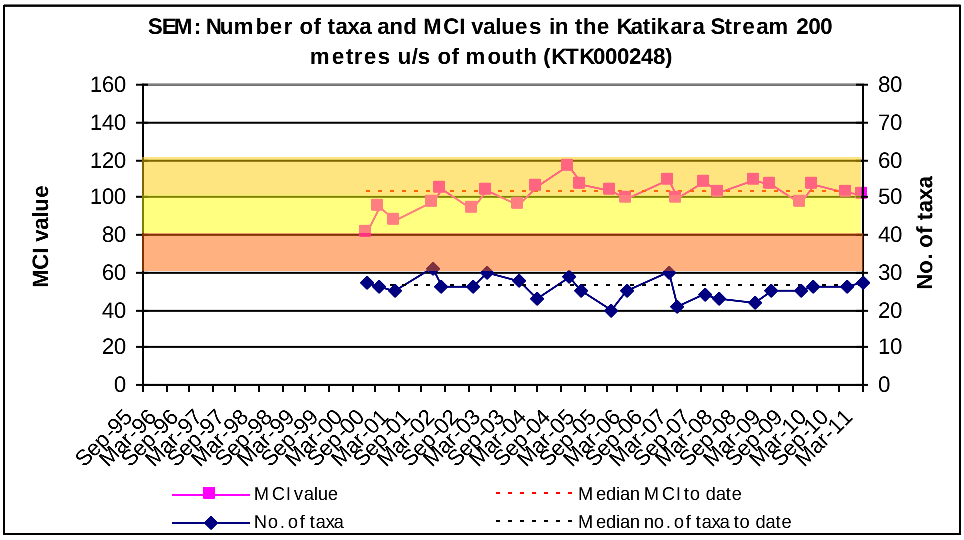


Figure 92 Numbers of taxa and MCI values in the Katikara Stream 200m u/s of the coast

A moderate range of richnesses (20 to 31 taxa) has been found with no indication of the effects of headwater erosion events noted at the upstream site.The median richness of 25 taxa has been more representative of typical richnesses in the lower reaches of ringplain streams and rivers. During the 2010-2011 period, spring (26 taxa) and summer (27 taxa) richnesses were almost identical and within two taxa of the median taxa number.

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, 2010 (102 units) and summer, 2011 (101 units) scores well above those typical for such a site and within 2 units of the historical median. These scores categorised this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of predictive relationshps (Table 2), 'better than expected' (spring and 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.

3.2.20.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 2010 [21 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Survey	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	4	19		
ANNELIDA	Oligochaeta	1	15	71		A
MOLLUSCA	*Latia*	5	2	10		
	Potamopyrgus	4	20	95		XA
CRUSTACEA	*Paratya*	3	2	10		
EPHEMEROPTERA	*Austroclima*	7	12	57	A	VA
	Coloburiscus	7	8	38	A	A
	Deleatidium	8	12	57	XA	VA
PLECOPTERA	*Zelandobius*	5	0	0	A	
	Zelandoperla	8	1	5		
COLEOPTERA	Elmidae	6	17	81	VA	XA
	Ptilodactylidae	8	2	10		
MEGALOPTERA	*Archichauliodes*	7	8	38	A	A
TRICHOPTERA	*Aoteapsyche*	4	18	86	A	VA
	Costachorema	7	6	29	A	
	Hydrobiosis	5	13	62		A
	Pycnocentrodes	5	18	86	XA	A
DIPTERA	*Aphrophila*	5	13	62	A	A
	Maoridiamesa	3	7	33		
	Orthocladiinae	2	17	81		VA
	Tanytarsini	3	3	14		
	Austrosimulium	3	7	33		

Prior to the current 2010-2011 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*)); five 'moderately sensitive' taxa (mayfly (*Austroclima*), elmid beetles, free-living caddisfly (*Hydrobiosis*), stony-cased caddisfly

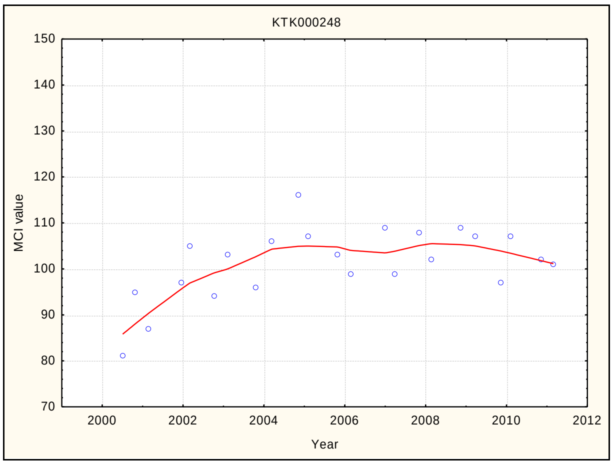
(*Pycnocentrodes*), and cranefly (*Aphrophila*)); and four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*)) and orthoclad midges). Nine of the historically characteristic taxa were dominant in the spring, 2010 community together with one 'moderately sensitive' taxon (stonefly (*Zelandobius*)) found previously at this site but not in abundance. Overall these comprised one 'highly sensitive' taxon, eight 'moderately sensitive', and one 'tolerant' taxa, whereas all but two of the same taxa plus one 'moderately sensitive' and two 'tolerant' taxa comprised the dominant taxa of the summer community. Eight of these 14 taxa were dominant in both spring and summer communities (Table 97) but a marked decrease in numerical abundances in certain 'sensitive' taxa and increased abundances within two 'tolerant' taxa were reflected in the seasonal drop in $SQMCI_s$ scores (Table 164 and 165) which decreased by 1.2 units in summer. All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 57% 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 (102 units) was significantly higher than the predictive altitude value while the summer score (101 units) was also higher than the predictive altitude value. Of the 23 surveys to date at this site, only 4% of MCI scores have been less than 85 units while 61% 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 2011 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 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 = 23
Kendall tau = +0.317
p level = 0.034 [>FDR, p = 0.088]
Significant at p <0.05;
N/S 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 eleven year monitoring period. This trend has levelled off over the most recent six year period with a slight downward trend very recently. where previously the trend was statistically significant, overall it does not have statistical significance now 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 remained very similar between spring and summer (1 to 2 units difference) at both sites with the percentage composition of 'tolerant' taxa increasing very slightly in the summer communities. Seasonal communities at the upper site shared only 13 common taxa (52% of the 25 taxa found at this site in 2010-2011) compared with 21 shared common taxa (61% of the 33 taxa found in the 2010-2011) 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 13 common taxa (36% of the 36 taxa at upper and lower reach sites) in spring and only 9 common taxa (27% of 33 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and especially in summer.

MCI score typically fell in a downstream direction in spring (by 33 units) but almostequally 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 2010-2011 period were only slightly lower in both spring and summer than average rate for the 1995 to 2010 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 ringplain 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, 2010 and summer, 2010-2011 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-two surveys have been undertaken in the Kapoaiaia Stream between 1995 and February 2010 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 together with the spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000250	22	19-31	25	83-129	106	26	127	25	122

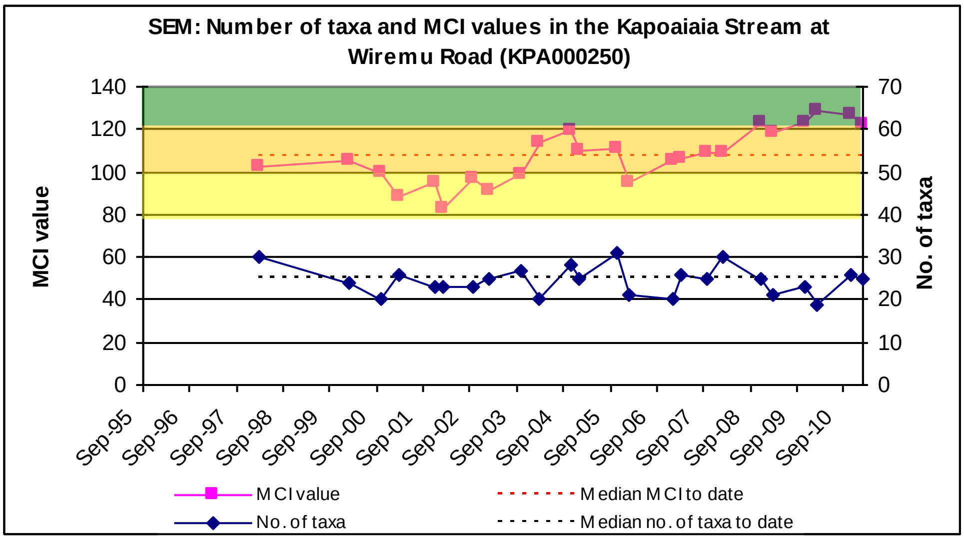


Figure 94 Numbers of taxa MCI values in the Kapoaiaia Stream at Wiremu Road

A moderate range of richnesses (19 to 31 taxa) has been found with a median richness of 25 taxa (more typical of richnesses in the mid-reaches of ringplain streams and rivers). During the 2010-2011 period, spring (26 taxa) and summer (25 taxa) richnesses were very similar and within one taxon of this median richness.

MCI values have had a relatively wide range (46 units) at this site, wider than typical of a site in the upper mid-reaches of a ringplain stream although this site is in very open farmland. The median value (106 units) has been lower than typical of upper mid-reach sites elsewhere on the ringplain. The spring, 2010 (127 units) and summer, 2011 (122 units) scores were significantly 21 and 16 units above the historical median respectively and in spring the score was only 2 units less than the 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 (106 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 2010-2011 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 2010 [22 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	12	55		
MOLLUSCA	*Potamopyrgus*	4	3	14		
CRUSTACEA	*Paracalliope*	5	1	5		
EPHEMEROPTERA	*Austroclima*	7	4	18		
	Coloburiscus	7	12	55	VA	A
	Deleatidium	8	14	64	XA	XA
	Nesameletus	9	3	14	VA	VA
PLECOPTERA	*Acroperla*	5	5	23		
	Zelandoperla	8	5	23	VA	
COLEOPTERA	Elmidae	6	20	91	A	XA
	Hydraenidae	8	1	5		
MEGALOPTERA	*Archichauliodes*	7	2	9		A
TRICHOPTERA	*Aoteapsyche*	4	20	91		A
	Costachorema	7	15	68		
	Hydrobiosis	5	9	41		
	Beraeoptera	8	0	0	XA	A
	Oxyethira	2	4	18		
	Pycnocentrodes	5	2	9	XA	A
DIPTERA	*Aphrophila*	5	18	82	A	
	Eriopterini	5	1	5		
	Maoridiamesa	3	18	82		
	Orthocladiinae	2	21	95	A	
	Tanytarsini	3	2	9		
	Muscidae	3	3	14		
	Austrosimulium	3	5	23		

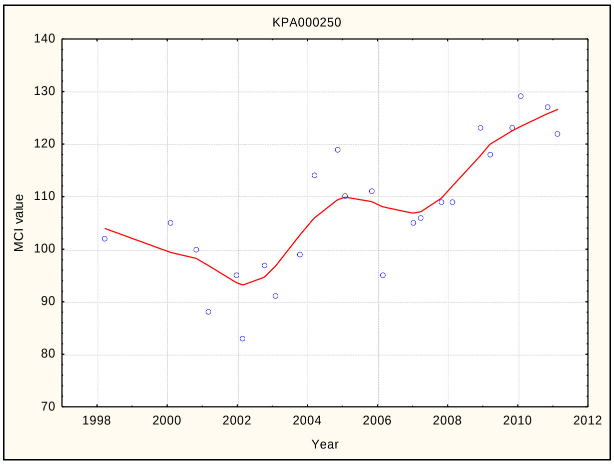
Prior to the current 2010-2011 period, 24 taxa have characterised the community at this site on occasions. These have comprised four 'highly sensitive', eleven 'moderately sensitive', and nine 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the upper mid-reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); four 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Costachorema*), and cranefly (*Aphrophila*)); and four 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)). Five of these predominant taxa were dominant in the spring, 2010 community together with two other 'highly sensitive' taxa, one other 'moderately sensitive' taxon, and another 'highly sensitive' taxon (flare-cased caddisfly (*Beraeoptera*)) not previously characteristic at this site. This taxon, previously found only in low numbers at this site, was extremely abundant coincident with a very sparse periphyton substrate cover which has seldom been a feature of this habitat previously. The summer, 2011 community was characterised by all but three of the taxa dominant in spring, together with an additional one 'moderately sensitive' and one 'tolerant' taxa all of which had been characteristic of this site's communities previously (Table 98). Despite some differences between the seasonally most dominant taxa compositions there was a minimal 0.1 unit $SQMCI_s$ difference between 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 9% to 90% of the past surveys, with the exception of the 'highly sensitive' flare-cased caddisfly (referenced above), which was found in (extreme) abundance for the first time at the site.

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 (106 units) is 3 units lower than the altitude prediction and 6 units lower than the distance predictive values. However, the spring, 2010 survey score (127 units) was significantly (Stark, 1998) higher than both predictive values while the summer, 2011 score (122 units) was also higher (by 10 to a significant 13 units) than both predictive values. Of the 24 surveys to date at this site, 50% of MCI scores have been less than 109 units while only 33% have been greater than 112 units indicating that scores in the 2010-2011 period were atypical and better than previous scores.

3.2.21.1.4 Temporal trends 1995 to 2011

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 = 24
Kendall tau = +0.555
p level = 0.0001 [>FDR, p = 0.001]
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 has been found over the thirteen year duration of this monitoring period and this trend was also significant at p<0.01 after FDR application principally over the period since 2003. There has been an ecologically significant variability in the wide (33 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 boundary 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 strong improvement also has been obvious since 2007 which has been maintained over the 2010-2011 period.

In terms of predictive relationships (Table 2) for a site in the upper mid-reaches of a ringplain stream, stream health had been mainly 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)

3.2.21.2.1 Taxa richness and MCI

Twenty-two surveys have been undertaken in the Kapoaiaia Stream at this mid-reach site at Wataroa Road between 1995 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000700	22	12-30	20	78-108	92	25	102	27	103

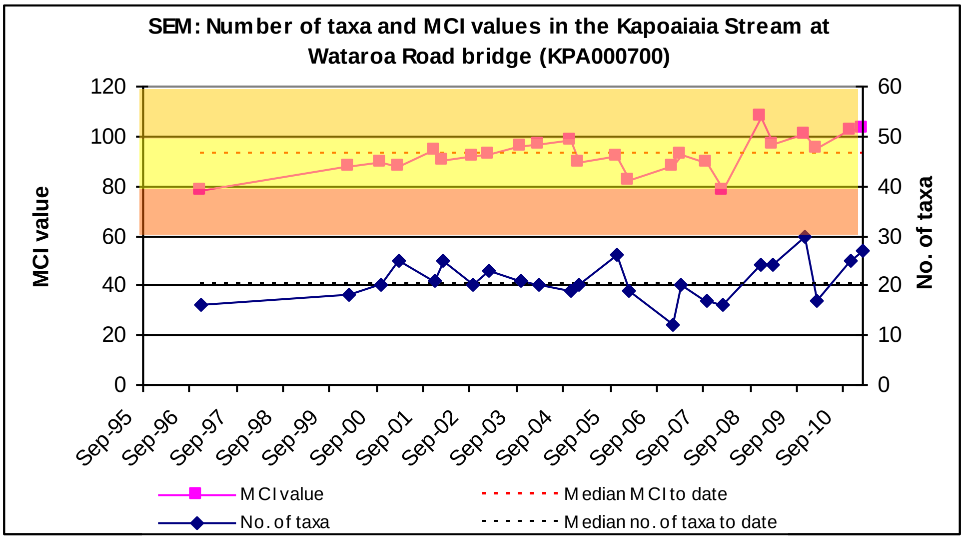


Figure 96 Numbers of taxa and MCI values in the Kapoaiaia Stream at Wataroa Road

A wide range of richnesses (12 to 30 taxa) has been found, with a median richness of 20 taxa, relatively typical of richnesses in the mid-reaches of ringplain streams and rivers. During the 2010-2011 period, spring (25 taxa) and summer (27 taxa) richnesses were similar and also well above median taxa number in spring and 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 (92 units) is lower than values typical of mid-reach sites elsewhere on the ringplain however, with the spring, 2010 (102 units) and summer, 2011 (103 units) scores higher than the historical median by 10 and a significant 11 units 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' (spring and summer) health for the mid-reaches of a ringplain river. The historical median score (92 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 2010-2011 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 February 2010 [22 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
PLATYHELMINTHES	*Cura*	3	1	5		
NEMATODA	Nematoda	3	1	5		
ANNELIDA	Oligochaeta	1	15	68		
	Lumbricidae	5	1	5		
MOLLUSCA	*Potamopyrgus*	4	6	27		
EPHEMEROPTERA	*Austroclima*	7	1	5		
	Coloburiscus	7	0	0	A	VA
	Deleatidium	8	8	36	XA	XA
PLECOPTERA	*Acroperla*	5	1	5	A	
COLEOPTERA	Elmidae	6	19	86	XA	XA
MEGALOPTERA	*Archichauliodes*	7	4	18	A	A
TRICHOPTERA	*Aoteapsyche*	4	15	68		XA
	Costachorema	7	11	50	A	
	Hydrobiosis	5	14	64		
	Oxyethira	2	2	9		
	Pycnocentrodes	5	4	18		A
DIPTERA	*Aphrophila*	5	13	59		A
	Maoridiamesa	3	13	59	A	
	Orthocladiinae	2	20	91	VA	VA
	Tanytarsini	3	3	14		
	Empididae	3	3	14		
	Muscidae	3	1	5		
	Austrosimulium	3	10	45		

Prior to the current 2010-2011 period, 22 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', nine 'moderately sensitive', and twelve '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 stream. Predominant taxa have included no 'highly sensitive' taxa; four 'moderately sensitive' taxa (elmid beetles, free-living caddisflies (*Costachorema* and *Hydrobiosis*), and cranefly (*Aphrophila*)); and four 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads). Eight of these historically characteristic taxa were dominant in the spring, 2010 community together with one 'moderately sensitive' taxon (mayfly (*Coloburiscus*)) previously not recorded in abundance. These eight taxa comprised one 'highly sensitive' taxon, five 'moderately sensitive' taxa, and two 'tolerant' taxa, whereas one 'highly sensitive', five 'moderately sensitive', and two 'tolerant' taxa also comprised the dominant taxa of the summer community. However, only five of these eleven taxa were dominant in both spring and summer communities (Table 101). An increased summer seasonal abundance within one 'tolerant' taxon in particular (caddisfly, *Aoteapsyche*) was reflected in the decrease of 0.6 unit in $SQMCI_s$ scores between spring and summer (Tables 166 and 167).

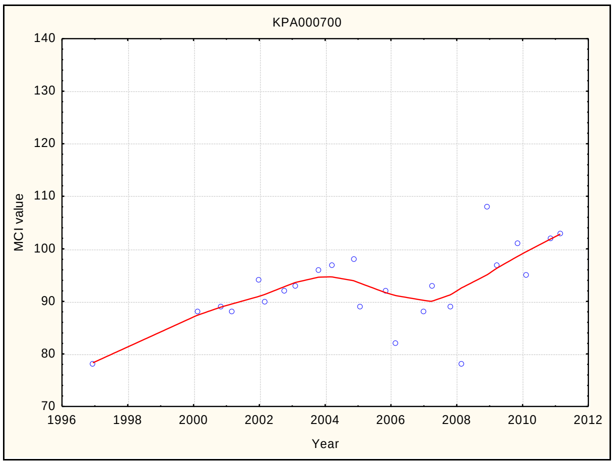
Four of the previous characteristic taxa found as very and/or extremely abundant by the seasonal surveys have characterised this site's communities on 36% to 91% of past survey oaccasions while the 'moderately sensitive' mayfly (*Coloburiscus*) was found as (very) abundant for the first time at this site.

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 (92) is 7 units lower than the altitude prediction and a significant 11 units lower than the distance predictive value. However, the spring, 2010 survey score (102 units) was 3 units higher than the predictive altitude value and only one unit lower than the predictive distance value. The summer, 2011 score (103 units) was higher by two units than the altitude value by 4 units and equivalent with the distance predictive value. Of the 24 surveys to date at this site, 88% of MCI scores have been less than 99 units while only 8% have been greater than 103 units, confirmation of the poorer than predicted historical biological 'health' at this site.

3.2.21.2.4 Temporal trends in 1995 to 2011 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 = 24
Kendall tau = +0.406
p level = 0.005 [>FDR, p = 0.022]
Significant at p <0.05 and 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 fourteen year trend which has been statistically significant (p< 0.05 after FDR). The range of LOWESS-smoothed scores (25 units) has been ecologically significant but has been influenced by an initial very low score. From 2000 to date this range has been 15 units which also has ecological significance.

Smoothed MCI scores have consistently indicated 'fair' generic stream health (Table 1) at this mid-catchment site, improving to 'good' in the 2010-2011 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, entering the 'better than expected' category in 2010-2011.

3.2.21.3 Upstream of coast site (KPA000950)

3.2.21.3.1 Taxa richness and MCI

Twenty-two surveys have been undertaken at this lower reach site near the coast in the Kapoaiaia Stream between 1995 and February 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000950	22	15-24	19	76-98	84	24	86	19	95

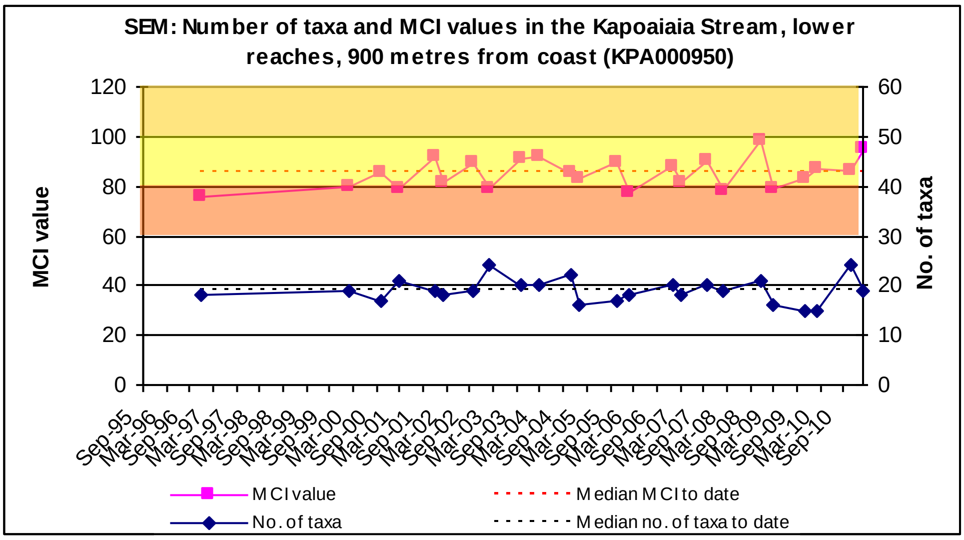


Figure 98 Numbers of taxa and MCI values in the Kapoaiaia Stream at the Cape Egmont (upstream of coast) site

A moderate range of richnesses (15 to 24 taxa) has been found with a median richness of 19 taxa relatively typical of richnesses in the lower reaches of ringplain streams and rivers. During the 2010-2011 period, spring (24 taxa) and summer (19 taxa) richnesses were dissimilar, but well above (spring) and equal with (summer), the median taxa number on both occasions coincident with patchy (spring) to very 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, 2010 (86 units) and summer, 2010 (95 units) scores were relatively typical for such a site but varied between 2 (spring) and a significant 11 (summer) units above 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' (spring) and 'better than expected' (summer) health 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 2010-2011 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 2010 [22 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
PLATYHELMINTHES	*Cura*	3	1	5		
NEMERTEA	Nemertea	3	1	5		
ANNELIDA	Oligochaeta	1	21	95	VA	VA
	Lumbricidae	5	1	5		
MOLLUSCA	*Potamopyrgus*	4	14	64	A	A
EPHEMEROPTERA	*Austroclima*	7	0	0	A	
	Deleatidium	8	1	5	VA	
COLEOPTERA	Elmidae	6	15	68	VA	VA
MEGALOPTERA	*Archichauliodes*	7	0	0		A
TRICHOPTERA	*Aoteapsyche*	4	17	77	A	VA
	Costachorema	7	1	5		
	Hydrobiosis	5	15	68	A	
	Oxyethira	2	5	23		
	Pycnocentrodes	5	9	41	VA	VA
DIPTERA	*Aphrophila*	5	5	23		
	Chironomus	1	1	5		
	Maoridiamesa	3	12	55	VA	
	Orthocladiinae	2	21	95	A	A
	Tanytarsini	3	4	18		A
	Muscidae	3	2	9		
	Austrosimulium	3	6	27		

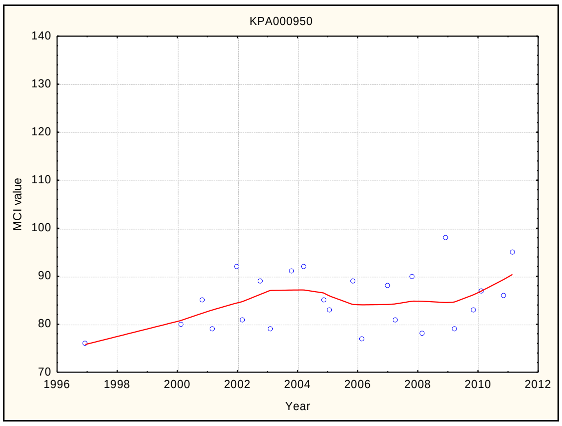
Prior to the current 2010-2011 period 19 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', six 'moderately sensitive', and twelve 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as might be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly sensitive' taxa; two 'moderately sensitive' taxa (elmid beetles and free-living caddisfly (*Hydrobiosis*)); and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)). Nine of the historically characteristic taxa were dominant in the spring 2010 community. These comprised one 'highly sensitive', three 'moderately sensitive', and five 'tolerant' taxa together with one additional 'moderately sensitive' taxon (mayfly (*Austroclima*)) not previously recorded in abundance at this site. Two 'moderately sensitive' and five 'tolerant' taxa comprised the dominant taxa in the summer community together with another 'moderately sensitive' taxon (dobsonfly (*Archichauliodes*)) not previously abundant at this site. Six of these twelve taxa were dominant in both spring and summer communities (Table 103). An increase in seasonal proportional dominances by 'tolerant' taxa in summer resulted in a small increase of 0.4 unit in seasonal $SQMCI_s$ scores (Table 166 and 167). The five taxa recorded as very abundant during spring and summer had characterized this site's communities on 5% to 95% 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, 2010 survey score (86 units) was equal with the altitude predictive value and 10 units less than the predictive distance value. The summer, 2011 score (95 units) was within 1 to 9 units of predictive values. Of the 24 surveys to date at this site, 54% of MCI scores have been less than 86 units while only 4% have been greater than 96 units.

3.2.21.3.4 Temporal trends in 1995 to 2011

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 = 24
Kendall tau = +0.176
p level = 0.227 [>FDR, p = 0.328]
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, although more pronounced, trend at the mid-catchment site at Wataroa Road. However, there has been an ecologically significant range (of 14 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 (10 units). In more recent years, 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, approaching 'better than exected' very recently.

3.2.21.4 Discussion

Seasonal MCI values atypically improved between spring and summer at two sites (Wataroa Road and near the coast) by 1 and 9 units respectively, while at the Wiremu Road site a more typical summer decrease in MCI score (5 units) was recorded. Seasonal communities shared 59% of the 32 taxa found at the upper mid-reach (Wiremu Road) site, 68% of 31 taxa at Wataroa Road, and 59% of 27 taxa at the furthest downstream site in the lower reaches near the coast, indicative of greater dissimilarity in seasonal community compositions at the upper mid-reach, Wiremu Road and lower reach sites.

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 41 units in spring and atypically, to a lesser degree, by 27 units in summer, over a river distance of 19.5 km. These seasonal falls in MCI scores equated to rates of decline of 2.10 units/km (spring) and 1.4 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 atypical 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 (3.2 units/km) and summer (2.4 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 (1.3 units/km) and summer (0.7 unit/km) rates of decline were well above 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 1.9 and 0.6 units per km respectively with an overall average rate of decline of 1.15 MCI units/km over the surveyed length. Therefore rates of MCI decline over the 2010-2011 period were higher than the average rates for the 1995 to 2010 period.

Community composition varied markedly through the upper mid-reach to lower reach length of the stream surveyed. A total of 38 taxa was recorded in spring of which only 14 taxa were present at all three sites (Table 166). These included one 'highly sensitive', nine 'moderately sensitive', and four 'tolerant' taxa with only one 'highly sensitive' taxon (mayfly (*Deleatidium*)) and one 'moderately sensitive' taxon (elmid beetles) abundant at all three sites. A slightly lower total of 33 taxa was found along the river's length by the summer survey (Table 167) of which 14 taxa were present at all three sites. Most of these were also widespread taxa in spring with an additional one 'highly sensitive' taxon and one fewer 'moderately sensitive' taxon and 'tolerant' taxon. Three 'moderately sensitive' taxa 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 slightly more pronounced in spring than in summer.

The 2010-2011 survey period found at least one additional characteristic taxon at each of the three sites; each of which was a 'sensitive' taxon indicative of some general improvement in preceeding habitat conditions. These taxa included the 'highly sensitive' caddisfly (*Beraeoptera*) which was characteristic of the upper mid reach community in both spring (extremely abundant) and summer; 'moderately sensitive' mayfly (*Coloburiscus*) which was characteristic of the mid reach (Wataroa Road) community on both occasionas (and very abundant in summer); and the 'moderately sensitive' mayfly (*Austroclima*) (spring) and dobsonfly (*Archichauliodes*) (summer) at the lower reach site.

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 (2010) and summer (2010 – 2011) surveys are presented in Table 168 and Table 169, Appendix 1.

3.2.22.1 Site upstream of Inglewood WWTP (KRP000300)

3.2.22.1.1 Taxa richness and MCI

Thirty-one surveys have been undertaken, between 1995 and February 2010, 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 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		October 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KRP000300	31	14-32	22	80-103	92	13	94	24	95

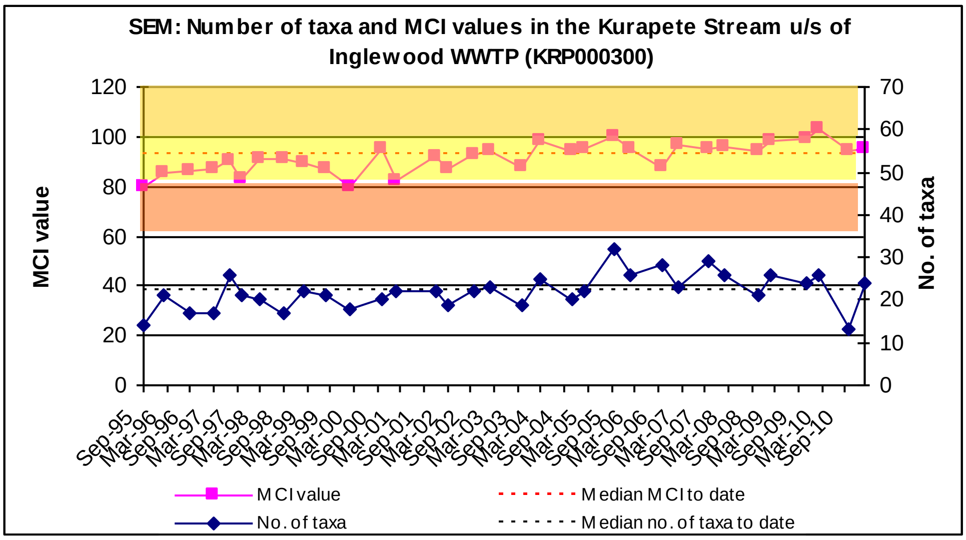


Figure 100 Numbers of taxa and MCI values in the Kurapete Stream upstream of the Inglewood WWTP

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 2010-2011 period spring (13 taxa) and summer (24 taxa) richnesses were very dissimilar, with the spring richness considerably lower (by 9 taxa) and summer richness two taxa higher than this median richness coincident with patchy periphyton layers on the predominantly stony-bouldery substrate of this partially shaded site. Several freshes in the catchment were recorded in the few months preceeding the spring survey.

MCI values have had a moderate range (23 units) at this site, typical of mid-reach sites on the ringplain. The historical median value (92 units) also has been typical of mid-reach sites rising outside the National Park elsewhere on the ringplain. The spring, 2010 (94 units) and summer, 2011 (95 units) scores were 2 units and 3 units above the historical median score respectively. They categorised this site as having 'fair' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' (spring and summer) health for the mid-reaches of a ringplain stream on these occasions. The historical median score (92 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 2010-2011 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 2010 [31 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
PLATYHELMINTHES	*Cura*	3	1	3		
NEMERTEA	Nemertea	3	1	3		
ANNELIDA	Oligochaeta	1	23	74		A
MOLLUSCA	*Potamopyrgus*	4	17	55	A	VA
CRUSTACEA	Paraleptamphopidae	5	3	10		
EPHEMEROPTERA	*Austroclima*	7	11	35		
	Deleatidium	8	1	3		
	Zephlebia group	7	11	35		VA
PLECOPTERA	*Acroperla*	5	2	6		
COLEOPTERA	Elmidae	6	14	45		VA
MEGALOPTERA	*Archichauliodes*	7	9	29		A
TRICHOPTERA	*Aoteapsyche*	4	22	71		A
	Hydrobiosis	5	3	10		
DIPTERA	*Aphrophila*	5	20	65		A
	Maoridiamesa	3	3	10		
	Orthocladiinae	2	24	77		
	Austrosimulium	3	20	65		A

Prior to the current 2010-2011 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 only one 'moderately sensitive' taxon (cranefly (*Aphrophila*)) and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), orthoclad midges, and sandfly (*Austrosimulium*)).

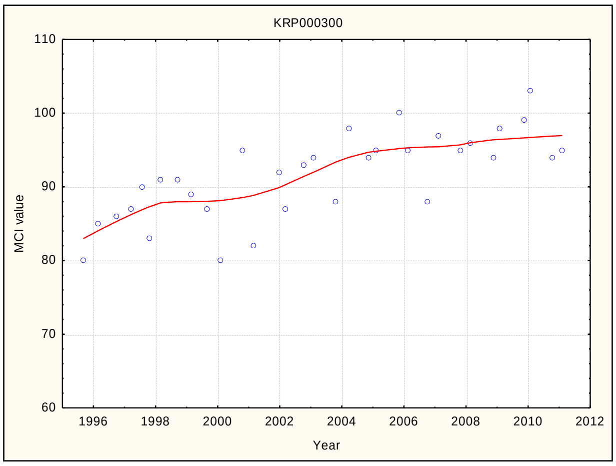
Only a single taxon of the historically characteristic taxa was dominant in the spring, 2010 community (Table 105) indicative of possible effects of the several freshes preceeding the spring period. The summer, 2010 community was characterised by four 'moderately sensitive' and four 'tolerant' taxon all of which previously had been characteristic of this site's communities (Table 105). The single dominant 'tolerant' taxon in spring resulted in a lower seasonal $SQMCI_s$ score than usual with seasonal $SQMCI_s$ scores increasing in summer by 0.9 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 35% to 55% of past survey occasions.

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 (92 units) is significantly 11 units lower than this altitude prediction while the spring survey score (94 units) and the summer score (95 units) were 8 to 9 units lower than the predictive value. Of the 33 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 typical of historical conditions.

3.2.22.1.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 33
Kendall tau = +0.587
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 has tended to plateau between 2004 and 2008 with some subsequent gradual improvement, while the overall range of LOWESS-smoothed MCI scores (14 units) has been ecologically significant.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) throughout the period . 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 sixteen year period although it was in the 'worse than expected' category prior to 1998 (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

Thirty-one 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 2010. 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 together with spring 2010 and summer 2011 results

Site code	SEM data (1996 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KRP000660	31	14-30	25	70-103	91	22	96	25	87

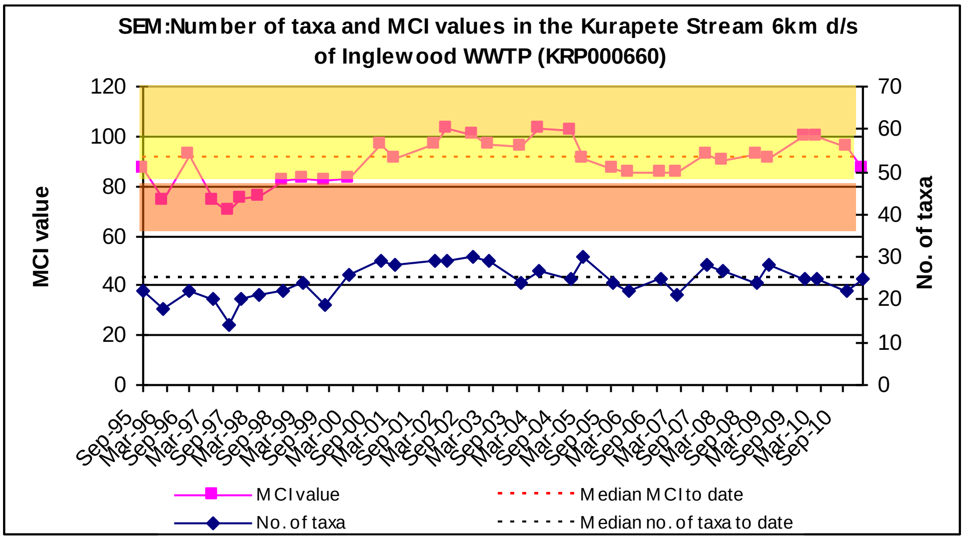


Figure 102 Numbers of taxa and MCI values in the Kurapete Stream, 6 km downstream of the Inglewood WWTP outfall

A moderate range of richnesses (14 to 30 taxa) has been found, with a median richness of 25 taxa (more representative of typical richnesses for the lower mid-reaches of ringplain streams rising outside the National Park boundary (TRC, 1999 (updated, 2011)). During the 2010-2011 period spring (22 taxa) and summer (25 taxa) richnesses were relatively similar and within 3 taxa of this median richness.

MCI values have had a moderately wide range (33 units) at this site. The median value (91 units) has been typical of lower mid-reach sites in similar streams elsewhere on the ringplain. The spring, 2010 (96 units) and summer, 2011 (87 units) scores were slightly higher (spring) and typical (summer) for such a site and 5 units above (spring), but 4 units lower (summer) than the historical median score. These scores categorised this site as having 'fair' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' (spring) and 'below expected' (summer) health for the lower mid-reaches of a ringplain stream coincident with improved physicochemical water quality following the diversion of Inglewood WWTP discharges out of the catchment. The historical median score (91 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

3.2.22.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 2010 [31 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
PLATYHELMINTHES	*Cura*	3	1	3		
NEMERTEA	Nemertea	3	3	10		
NEMATODA	Nematoda	3	1	3		
ANNELIDA	Oligochaeta	1	28	90		A
MOLLUSCA	*Potamopyrgus*	4	17	55	VA	VA
CRUSTACEA	Ostracoda	1	1	3		
EPHEMEROPTERA	*Austroclima*	7	6	19		
	Coloburiscus	7	4	13		
	Deleatidium	8	0	0	A	A
	Zephlebia group	7	7	23		A
PLECOPTERA	*Zelandobius*	5	6	19	A	
COLEOPTERA	Elmidae	6	16	52	A	A
MEGALOPTERA	*Archichauliodes*	7	7	23	A	
TRICHOPTERA	*Aoteapsyche*	4	17	55	A	VA
	Costachorema	7	2	6		
	Hydrobiosis	5	13	42		A
	Oxyethira	2	12	39		A
	Pycnocentrodes	5	6	19		
DIPTERA	*Aphrophila*	5	21	68	A	A
	Maoridiamesa	3	8	26		
	Orthocladiinae	2	30	97	A	A
	Tanytarsini	3	3	10		A
	Empididae	3	2	6		
	Muscidae	3	3	10		
	Austrosimulium	3	16	52		A

Prior to the current 2010-2011 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 two 'moderately sensitive' taxa (elmid beetles and cranefly (*Aphrophila*)) and five 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), orthoclad midges, and sandfly (*Austrosimulium*)).

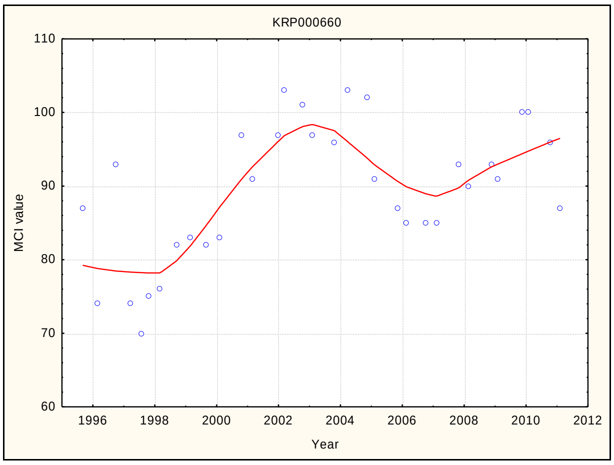
Eight taxa were dominant in the spring, 2010 community and comprised five of the predominant taxa (above) together with two of the other 'moderately sensitive' historically characteristic taxa and one 'highly sensitive' taxon (mayfly (*Deleatidium*)) not previously recorded as abundant at this site. The summer, 2011 community was characterised by six of the taxa dominant in spring (including the one 'highly sensitive' mayfly taxon), together with two additional 'moderately sensitive' taxa and four 'tolerant' taxa which previously had been characteristic of this site's communities (Table 107). The increased abundances of certain 'tolerant' taxa in summer was reflected in the small seasonal decrease in $SQMCI_s$ scores of 0.7 unit (Tables 168 and 169). The two taxa which were recorded as very abundant during spring and/or summer had characterised this site's communities on 55% of past surveys.

3.2.22.2.3 Predicted stream 'health'

The Kurapete Stream rises below the National Park boundary and the site 6 km downstream of the Inglewood WWTP outfall is in the lower mid-reaches at an altitude of 120 m asl. 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 (91 units) is 6 units lower than altitude prediction and the spring survey score (96 units) and the summer score (87 units) were one and 10 units lower than the predictive value respectively. Of the 33 surveys to date at this site, 73% of MCI scores have been less than 97 units, indicating that the current spring and summer MCI scores were more typical of historical conditions although 50% of scores have equalled or exceeded 97 units since wastewater discharges were directed out of the stream in 2000.

3.2.22.2.4 Temporal trends in 1995 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the sixteen 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 = 33
Kendall tau = +0.342
p level = 0.005 [>FDR, p = 0.022]
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 after 2000 (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 sixteen-year trend has been significant after FDR application coincident with a 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 again more recently including 2010-2011 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), indicative of the positive 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 site upstream of the Inglewood WWTP outfall where the score improved by one unit. However, a more typical summer decrease (of 9 units) was found at the site 6km downstream. Seasonal communities shared only 42% of the 26 taxa common to the mid-reach site and 52% of the 31 taxa common to the downstream, lower mid-reach site indicative of marked seasonal community dissimilarities which increased in an upstream direction where the effects of preceeding spring freshes were more pronounced.

MCI score increased by 2 units in spring and decreased by 8 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 1.3 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 0.3 MCI unit/km over the surveyed length. Therefore rates of MCI decline over the 2010-2011 period were not greatly different in spring but higher in summer than the average rate for the 1995 to 2010 period.

Community composition varied markedly through the mid-reach to lower mid-reach length of the stream surveyed. A lower than usual total of 24 taxa was recorded in spring of which 11 taxa were present at both sites. These included one 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa with only one 'tolerant' taxon abundant at both sites, again indicative of the preceeding impacts of freshes prior to the spring survey. A higher total of 33 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 two more 'moderately sensitive' and 'tolerant' taxa. Seven taxa were abundant at both sites in summer; four 'tolerant' taxa and three 'moderately sensitive' taxa. Dissimilarities in spatial community structure along the surveyed length of the Kurapete Stream were slightly more pronounced in spring than in summer, unlike most seasonal structures to date.

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 whereas the downstream site was established for biological trend monitoring purposes in the 2008-2009 period.

The results of spring (2010) and summer (2010-2011) surveys are summarized in Tabled 170 and 171, Appendix I.

3.2.23.1Skeet Road site (WKR000500)

3.2.23.1.1 Taxa richness and MCI

Eleven surveys have been undertaken, between 1996 and February 2010, 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1996 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000500	11	20-28	23	88-104	94	23	102	20	100

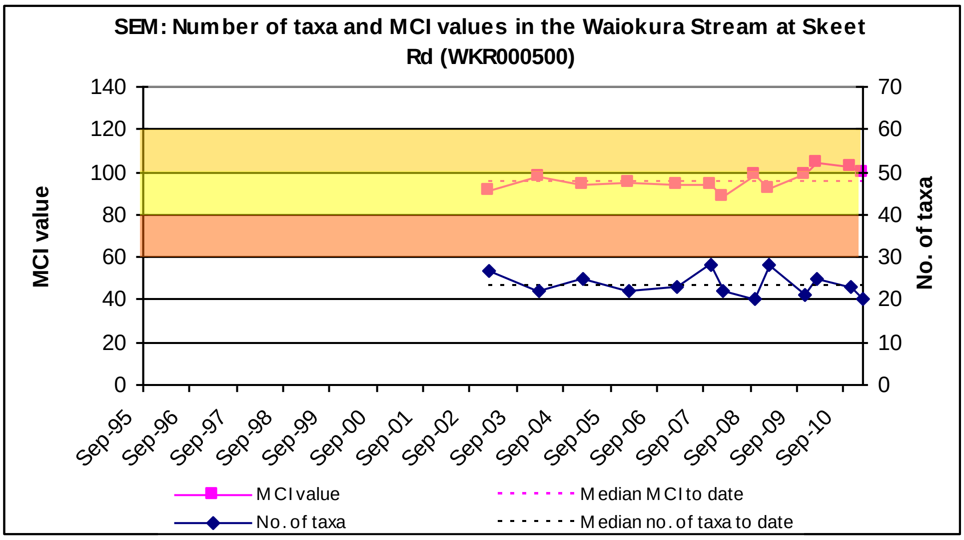


Figure 104 Numbers of taxa and MCI values in the Waiokura Stream at Skeet Road

A relatively narrow range of richnesses (20 to 28 taxa) has been found to date with a median richness of 23 taxa more typical of richnesses in the mid reaches of ringplain streams rising outside the National park boundary. During the 2010-2011 period spring (23 taxa) and summer (20 taxa) richnesses were within three taxa of this median richness coincident with patchy periphyton on the predominantly gravel-cobble substrate of this site in spring and a similar periphyton layer in summer (after a slightly longer flow recession period).

MCI values have had a relatively narrow range (16 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) has been typical of mid-reach sites in streams rising outside the National Park elsewhere on the ringplain, and the spring, 2010 (102 units) and summer, 2011 (100 units) scores were 8 units and 6 units above the historical median respectively. They categorised this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' and '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 2010-2010 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 February 2010 [11 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	1	9		
ANNELIDA	Oligochaeta	1	8	73	A	
MOLLUSCA	*Potamopyrgus*	4	4	36		
CRUSTACEA	*Paracalliope*	5	1	9		
	Paraleptamphopidae	5	1	9		
EPHEMEROPTERA	*Austroclima*	7	11	100	VA	XA
	Coloburiscus	7	1	9	A	
	Deleatidium	8	6	55		A
	Zephlebia group	7	3	27	VA	
PLECOPTERA	*Zelandobius*	5	0	0	A	
COLEOPTERA	Elmidae	6	11	100	VA	XA
MEGALOPTERA	*Archichauliodes*	7	6	55		A
TRICHOPTERA	*Aoteapsyche*	4	11	100	VA	XA
	Costachorema	7	1	9		
	Hydrobiosis	5	4	36		
	Pycnocentrodes	5	5	45		
DIPTERA	*Aphrophila*	5	1	9		
	Maoridiamesa	3	2	18	VA	
	Orthocladiinae	2	6	55	VA	
	Tanytarsini	3	1	9		

Prior to the current 2010-2011 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 moderately 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*)); three 'moderately sensitive' taxa (mayfly (*Austroclima*), elmid beetles, and dobsonfly (*Archichauliodes*)); and four 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and orthoclad midges).

Eight of the historically characteristic taxa were dominant in the spring, 2010 community comprising five of the predominant taxa (above) together with two other 'moderately sensitive' and one 'tolerant' taxa. The summer, 2011 community was characterised by fewer taxa; three of the taxa dominant in spring, together with an additional one 'highly sensitive', and one 'moderately sensitive' taxa, both of which previously had been characteristic of this site's communities. Atypical increased summer abundances within several 'sensitive' dominant taxa, resulted in an increase in the summer seasonal $SQMCI_s$ score (0.9 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 18% to 100% of past survey occasions (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 (102 units) and the summer score (100 units) were within 2 units of the predictive value. Of the 13 surveys to date at this site, 77% of MCI scores have been less than 100 units, indicating that the current spring and summer MCI scores were 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 2011 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 this 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. However, 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.

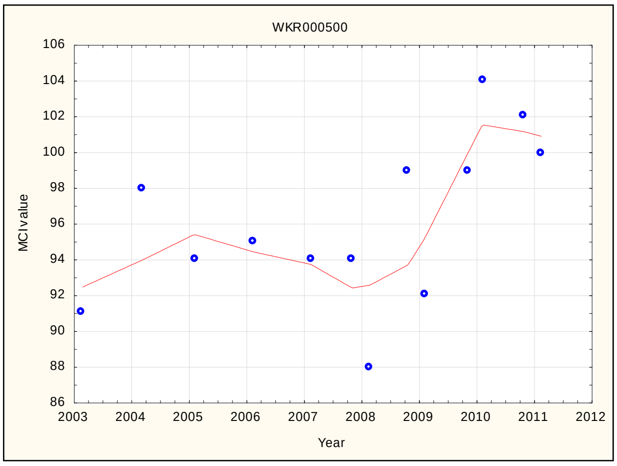


Figure 105 LOWESS trend plot of MCI data at the Skeet Road site

More recently there has been relatively strong temporal improvement in MCI scores at this site. The LOWESS-smoothed range of MCI scores (9 units) has not been of ecological significance but increases in scores may have been related to improvements in farming practices and/or wastes disposal in the rural catchment between the stream's seepage sources (below the National Park) and mid reaches at Skeet Road, 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 eight year period although it most recently approached 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

Six surveys have been undertaken at this more recently established lower reach site in the Waiokura Stream at Manaia between 2007 and February 2010. 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, , together with spring 2010 and summer 2011 results

Site code	SEM data (2007 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Feb 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000700	6	16-26	23	92-103	97	23	100	22	101

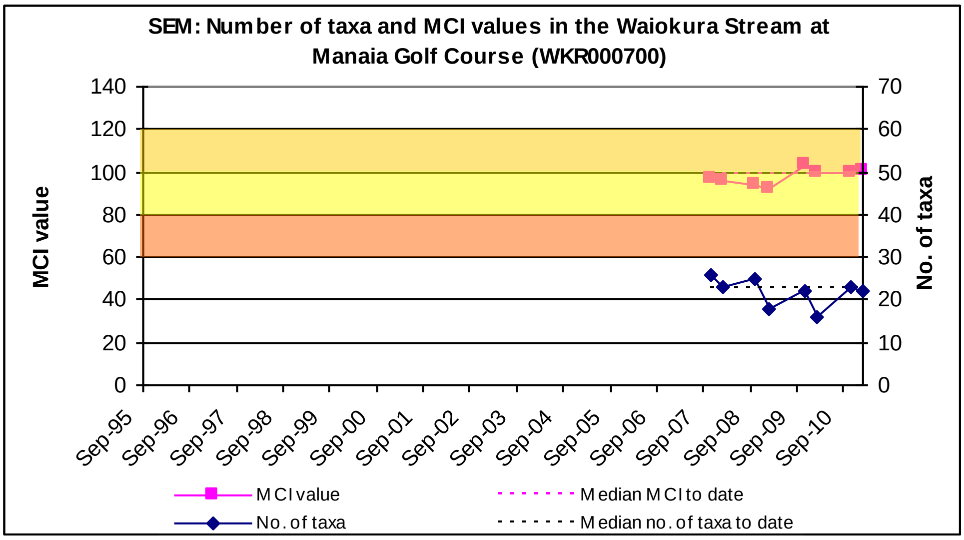


Figure 106 Numbers of taxa and MCI values in the Waiokura Stream at Manaia Golf course

A moderate range of richnesses (16 to 26 taxa) has been found, with a median richness of 23 taxa (more representative of typical richnesses for the lower reaches of ringplain streams rising outside the National Park boundary). During the 2010-2011 period spring (23 taxa) and summer (22 taxa) richnesses were very similar and within one taxon of this median richness.

MCI values have had a narrow range (11 units) at this site due in part to the very short duration of the monitoring period to date. The median value (97 units) has been slightly higher than typical of lower reach sites elsewhere on the ringplain however. The spring, 2010 (100 units) and summer, 2011 (101 units) scores were also higher than typical for such a site; but insignificantly 3 and 4 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 (97 units) placed this site in the 'fair' and 'better than expected' categories for generic and predictive methods of assessment respectively.

3.2.23.2.2 Community composition

Characteristic macroinvertebrate taxa in the communties at this site for the short period prior to the 2010-2011 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 February 2010 [6 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMATODA	Nematoda	3	1	17		
ANNELIDA	Oligochaeta	1	5	83	A	A
MOLLUSCA	*Potamopyrgus*	4	3	50	A	A
CRUSTACEA	*Paracalliope*	5	1	17		
EPHEMEROPTERA	*Austroclima*	7	6	100	VA	XA
	Coloburiscus	7	3	50	A	VA
	Zephlebia group	7	6	100	A	VA
PLECOPTERA	*Zelandobius*	5	1	17	A	
COLEOPTERA	Elmidae	6	6	100	VA	XA
MEGALOPTERA	*Archichauliodes*	7	5	83	A	A
TRICHOPTERA	*Aoteapsyche*	4	5	83	VA	VA
	Hydrobiosis	5	1	17		
	Pycnocentrodes	5	1	17		

Prior to the current 2010-2011 period, 13 taxa had characterised the community at this site on occasions. These have comprised no 'highly sensitive', nine '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*)).

Nine of these historically characteristic taxa were dominant in the spring, 2010 community comprising eight of the predominant taxa (above). The summer, 2011 community was characterised by all but one of the taxa dominant in spring, with one less 'moderately sensitive' taxon (Table 111). The increased summer abundances within four 'moderately sensitive' taxon in particular was reflected in the increase in seasonal $SQMCI_s$ scores of 0.7 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 50% to 100% of past surveys.

3.2.23.2.3 Predicted stream 'health'

The Waiokura Stream rises below the National Park boundary and the site at the Manaia golf course is in the lower reaches at an altitude of 70 m asl. 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 (97 units) is slightly above this altitude prediction coincident with patchy riparian vegetation cover through the Manaia golf course. Both the spring survey score (100 units) and the summer score (101 units) were higher than this predictive value by up to 4 units. Of the eight 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 most past scores.

3.2.23.2.4 Temporal trends in 2007 to 2011 data

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the five 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.

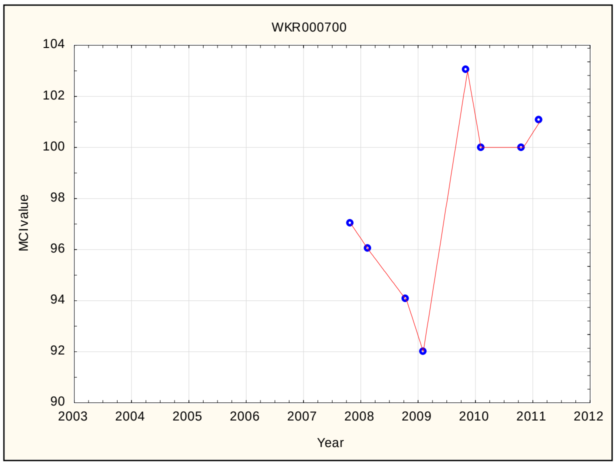


Figure 107 LOWESS trend plot of MCI data for the Manaia golf course

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 this 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 at this stage.

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 more recently. 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 present through the golf course reach of this stream.

3.2.23.3 Discussion

Seasonal MCI values typically decreased (but only by 2 units) at the mid-reach site and atypically increased (by 1 unit) between spring and summer at the site in the lower reaches. Seasonal communities shared 65% of the 26 taxa common at the mid-reach site and 55% of 29 taxa at the downstream site in the lower reaches at Manaia indicative of a small increase 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 decreased by 2 units in spring but atypically (for a ringplain stream) improved, although only by 1 unit in summer, between the more open farmland mid-reach site (Skeet Road) and the lower reach Manaia golf course site, coincident with some improvement in 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 0.2 unit/km (spring) and nil units/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 (but an improvement of 4 units) 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 2010-2011 period in spring and summer were probably typical in terms of the average rate for the 2007 to 2010 period.

Community composition varied through the mid reach to lower reach length of the stream surveyed. A total of 28 taxa was recorded in spring of which 18 taxa were present at both sites. These included no 'highly sensitive', eleven 'moderately sensitive', and seven 'tolerant' taxa with five 'moderately sensitive' taxa and two 'tolerant' taxa abundant at both sites. A similar total (27 taxa) was found along the stream's surveyed length by the summer survey of which 15 taxa were present at both sites. There were very similar to the widespread taxa in spring with an increase of one 'highly sensitive' taxon, and a decrease of two 'moderately sensitive' and two '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 slightly 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 from the river 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, 2010 survey are presented in Table 172 and the summer, 2010–2011 survey in Table 173, Appendix I.

3.2.24.1Upper Tangahoe Valley Road site (TNH000090)

3.2.24.1.1 Taxa richness and MCI

Six surveys have been undertaken at this upper reach site in the Tangahoe River between 2007 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Mar 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000090	16	17-30	23	92-106	98	25	96	28	95

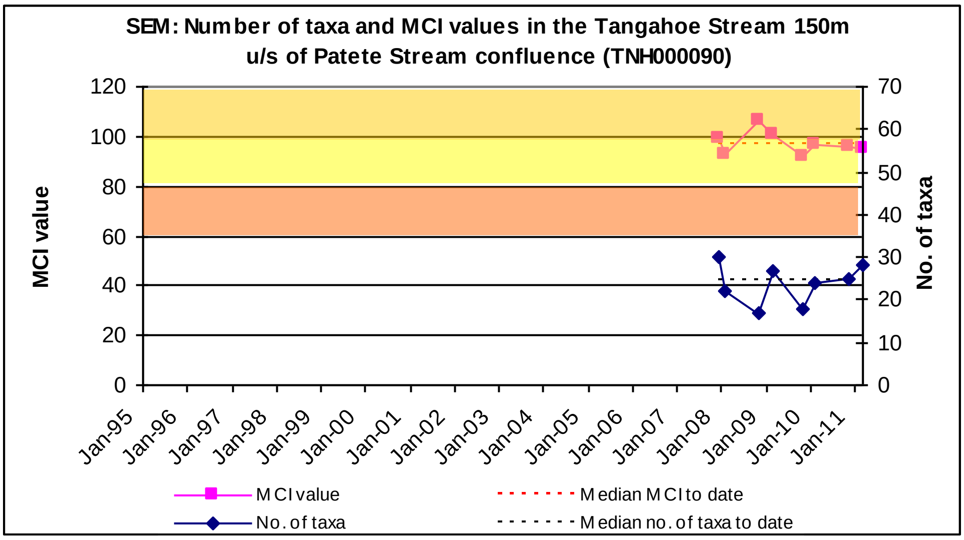


Figure 108 Numbers of taxa and MCI values in the Tangahoe River at Upper Tangahoe Valley Road

A relatively wide range of richnesses (17 to 30 taxa) has been found with a moderate median richness of 23 taxa (lower than typical richnesses in the upper reaches of eastern hill country rivers) but higher than median richness (19 taxa) for sites at this relatively low altitude (85 m asl) (TRC, 1999 (updated, 2011)). During the 2010-2011 period, spring (25 taxa) and summer (28 taxa) richnesses were above this median richness.

MCI values have had a relatively narrow range (14 units) at this site, more typical of a site in the upper reaches of streams and rivers. The median value (98 units) has been more typical of mid reach sites elsewhere and 6 units above the median score recorded by 43 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 2011)). The spring, 2010 (96 units) and summer, 2011 (95 units) scores were 2 to 3 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 (98 units) place this site in the 'fair' category for the generic method of assessment.

3.2.24.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2010-2011 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 2010 [6 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	3	50	A	A
MOLLUSCA	*Potamopyrgus*	4	6	100	A	VA
EPHEMEROPTERA	*Austroclima*	7	6	100	A	A
	Deleatidium	8	4	67	XA	VA
	Zephlebia group	7	3	50		VA
PLECOPTERA	*Megaleptoperla*	9	1	17		
COLEOPTERA	Elmidae	6	6	100	VA	VA
MEGALOPTERA	*Archichauliodes*	7	1	17		
TRICHOPTERA	*Aoteapsyche*	4	2	33		
	Hydrobiosis	5	1	17	A	
DIPTERA	Orthocladiinae	2	0	0	A	
	Austrosimulium	3	4	67	XA	VA

Prior to the current 2010-2011 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*)); three 'moderately sensitive' taxa (mayflies (*Austroclima* and *Zephlebia* group) and elmid beetles); and three 'tolerant' taxa (snail (*Potamopyrgus*), oligochaete worms, and sandfly (*Austrosimulium*)). Six of these predominant taxa were dominant in the spring, 2010 community together with one other historically characteristic taxon and one 'tolerant' taxon (orthoclad midges) not previously recorded in abundance at this site. The summer, 2011 community was characterised by six of the taxa dominant in spring, together with an additional one taxon; which previously had been characteristic of this site's communities (Table 113). Despite several seasonal differences in characteristic taxa, the similarity in the most numerically dominant taxa in spring and summer surveys was reflected in the identical 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 50% to 100% of past survey occasions.

3.2.24.1.3 Predicted 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.

3.2.24.1.4 Temporal trends in 2007 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the four years (2007-2011) 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.

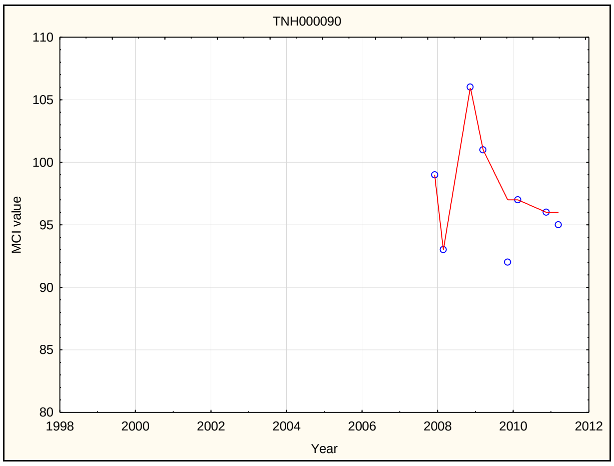


Figure 109 LOWESS trend plot of MCI data for the upper Tangahoe Valley site

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 MCI scores (14 units) may be ecologically significant but cannot be fully assessed until the monitoring period is of sufficient duration.

MCI scores ranging from 'fair' to 'good' generic river health (Table 1) have been recorded over the four year period (Figure 109).

3.2.24.2 Tangahoe Valley Road bridge site (TNH000200)

3.2.24.2.1 Taxa richness and MCI

Six surveys have been undertaken at this mid reach site in the Tangahoe River between 2007 and February 2010. 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Mar 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000200	6	20-33	26	92-108	106	22	102	26	98

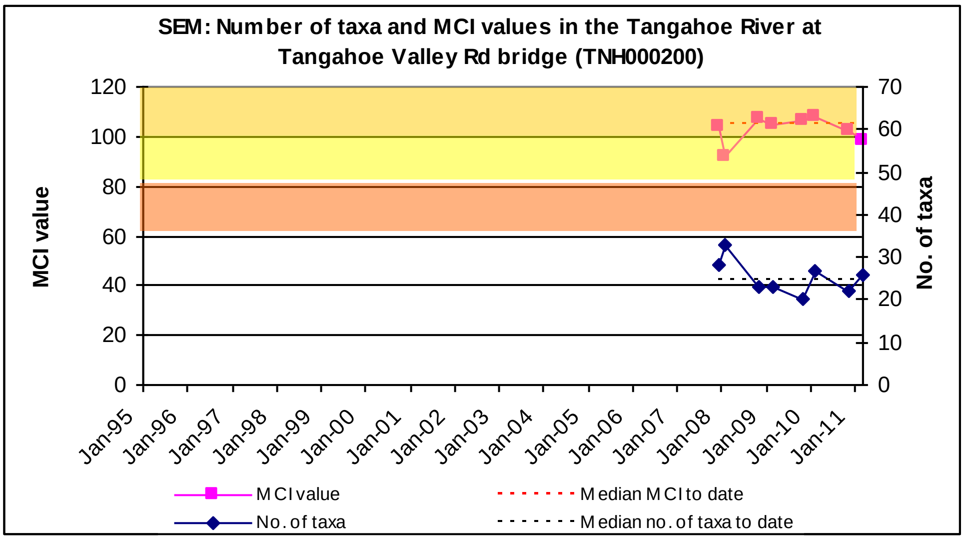


Figure 110 Numbers of taxa and MCI values in the Tangahoe River at Tangahoe Valley Road bridge

A moderate range of richnesses (20 to 33 taxa) has been found with a relatively good median richness of 26 taxa (typical of richnesses in the mid-reaches of eastern hill country rivers). During the 2010-2011 period, spring richness (22 taxa) was below median, while summer richness (26 taxa) was equivalent to this median taxa number.

MCI values have had a moderate range (16 units) at this site and typical of a site in the mid-reaches of eastern hill country streams and rivers. The median value (106 units) has also been typical of mid-reach sites elsewhere and four units above the median score recorded by 14 previous surveys at 'control' sites located at similar altitudes in eastern hill country rivers and streams (TRC, 1999 (updated, 2011)). The spring, 2010 (102 units) and summer, 2011 (98 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 spring and 'fair' health in summer. The historical median score (106 units) 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 2010-2011 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 2010 [6 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	2	33		
MOLLUSCA	*Potamopyrgus*	4	4	67		VA
EPHEMEROPTERA	*Austroclima*	7	6	100	VA	VA
	Coloburiscus	7	1	17		VA
	Deleatidium	8	4	67	VA	A
	Rallidens	9	1	17		
	Zephlebia group	7	5	83		VA
PLECOPTERA	*Acroperla*	5	1	17	A	
	Zelandobius	5	2	33	A	
COLEOPTERA	Elmidae	6	6	100	VA	XA
MEGALOPTERA	*Archichauliodes*	7	2	33		A
TRICHOPTERA	*Aoteapsyche*	4	6	100		A
	Hydrobiosis	5	4	67		A
	Oxyethira	2	2	33		
	Pycnocentrodes	5	1	17		
DIPTERA	*Aphrophila*	5	4	67		
	Orthocladiinae	2	4	67		
	Tanytarsini	3	4	67		
	Austrosimulium	3	2	33		

Prior to the current 2010-2011 period, 19 taxa have characterised the community at this site on occasions. These have comprised two ‘highly sensitive’, ten ‘moderately sensitive’, and seven ‘tolerant’ taxa i.e. a 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*); five ‘moderately sensitive’ taxa (mayflies (*Austroclima* and *Zephlebia* group), elmid beetles, caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)); and four ‘tolerant’ taxa (snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), and midges (tanytarsids and orthoclads)). Three of these predominant taxa were dominant in the spring, 2010 community together with two other taxa which had been characteristic previously. The summer, 2011 community was characterised by three of the taxa dominant in spring, together with an additional six taxa; all of which previously had been characteristic of this site’s communities (Table 115). Despite marked increase in summer abundances of several ‘sensitive’ taxa, a reduction in abundance of one ‘highly sensitive’ taxon and a marked increase in abundance of ‘tolerant’ snails was reflected in the reduction in summer $SQMCI_s$ score (by 0.5 unit (Tables 172 and 173)). All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site’s communities on 17% 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.

3.2.24.2.4 Temporal trends in 2070 to 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the four years (2007-2011) 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.

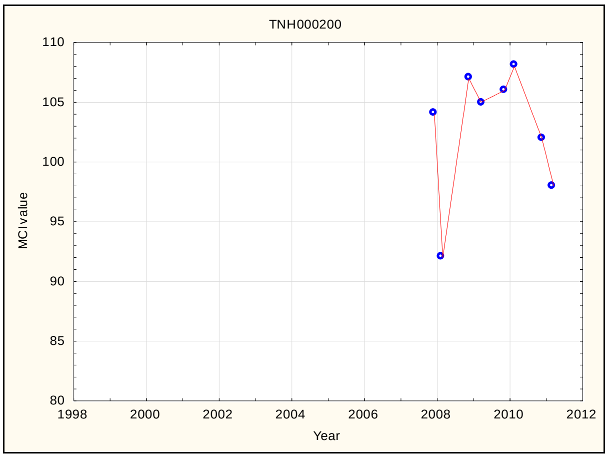


Figure 111 LOWESS trend plot of MCI data for the Tangahoe Valley Road bridge site

No temporal trend in MCI scores may yet be interpreted for this mid river reach, eastern hill country site. The range of MCI scores (15 units) may have been ecologically significant, but cannot be accurately assessed until the monitoring period is of sufficient duration.

MCI scores have mainly indicated 'good' generic river health (Table 1) over the three year period.

3.2.24.3Site downstream of railbridge (TNH000515)

3.2.24.3.1 Taxa richness and MCI

Five surveys have been undertaken at this lower reach site in the Tangahoe River between 1995 and February 2010 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, together with spring 2010 and summer 2011 results

Site code	SEM data (1995 to Feb 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2010		Mar 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000515	7	13-26	17	84-104	89	20	98	21	87

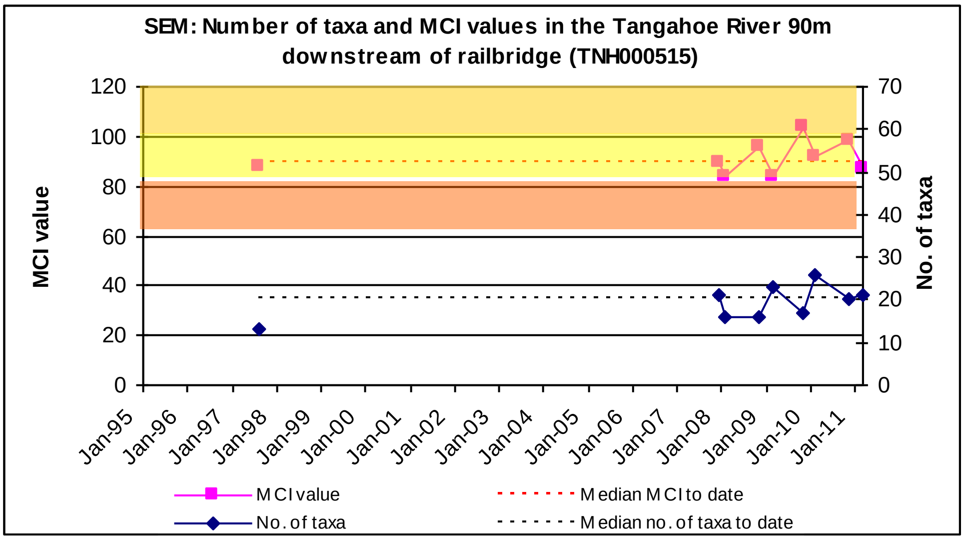


Figure 112 Numbers of taxa and MCI values in the Tangahoe River downstream of the railbridge

A moderate range of richnesses (13 to 26 taxa) has been found with a typical median richness of 17 taxa for a site in the lower reaches of an eastern hill country river. During the 2010-2011 period, spring (20 taxa) and summer (21 taxa) richnesses were similar and above this median richness.

MCI values also have had a moderate range (20 units) at this site, slightly narrower than 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 (89 units) has been more typical of lower reach sites elsewhere and a significant 14 units higher than the median score recorded by 210 previous surveys at 'control' sites located at similar altitudes (to this site) in eastern hill country rivers and streams (TRC, 1999 (updated, 2011)). The spring, 2010 (98 units) and summer, 2011 (87 units) scores were 9 units above and 2 units below the historical median respectively. These scores categorised this site as having 'fair' health generically (Table 1) in both spring and summer. The historical median score (89 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 2010-2011 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 2010 [7 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
NEMERTEA	Nemertea	3	0	0		A
ANNELIDA	Oligochaeta	1	6	86	A	VA
MOLLUSCA	*Latia*	5	2	29		A
	Potamopyrgus	4	7	100		VA
COLEOPTERA	Elmidae	6	6	86	A	XA
TRICHOPTERA	*Aoteapsyche*	4	6	86	VA	XA
	Pycnocentrodes	5	2	29		
DIPTERA	*Aphrophila*	5	3	43	A	
	Maoridiamesa	3	2	29	A	
	Orthocladiinae	2	5	71	VA	A
	Austrosimulium	3	1	14		

Prior to the current 2010-2011 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 relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of an eastern hill-country river. Predominant taxa have included one 'moderately sensitive' taxon (elmid beetles) 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, 2010 community together with two other historically characteristic taxa. The summer, 2011 community was characterised by four of the taxa dominant in spring, together with an additional three taxa; one of which ('tolerant' nemertean worms) previously had not been characteristic of this site's communities (Table 117). Despite several seasonal differences in characteristic taxa, (in particular the increased numerical abundances of several 'tolerant' taxa in the summer survey), a significant increase in the abundance of 'moderately sensitive' elmid beetles, was reflected in the small increase (1.1 units) 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 71% 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 2011 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the mainly four 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.

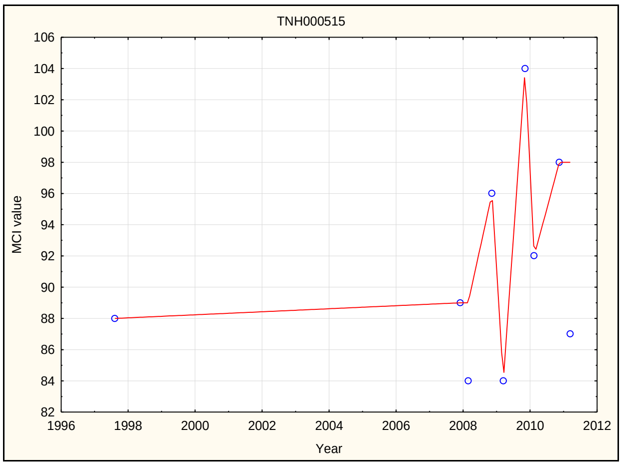


Figure 113 LOWESS trend plot of MCI data for the Tangahoe River site downstream of the railbridge

No temporal trend in MCI scores may yet be inferred for this lower river reach, eastern hill country site. The range of MCI scores (20 units) has been ecologically significant but this significance cannot be properly assessed until the monitoring period is of sufficient duration and frequency for valid interpretation.

MCI scores have mainly indicated 'fair' generic river health (Table 1) over the short period (Figure 113).

3.2.24.4Discussion

Seasonal MCI values typically decreased between spring and summer at the upper two sites (Upper Tangahoe Valley Road and Tangahoe Valley Road bridge) but only by 1 and 4 units respectively, while at the railbridge site in the lower reaches, a larger, more typical summer decrease in MCI score (11 units) was recorded. Seasonal communities shared 51% of the 35 taxa found at the upper reach (Upper Tangahoe Valley Road) site, 55% of 31 taxa at Tangahoe Valley Road bridge site, and 52% of 27 taxa at the furthest downstream site in the lower reaches (railbridge), indicative of almost equivalent similarities in seasonal community compositions somewhat atypical of downstream trends of decreasing similarity elsewhere.

The spring MCI scores atypically increased by 6 units in a downstream direction over the 8.9 km reach between the upper and mid sites and also increased (by 2 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 8 units) representing a rate of decrease of 0.3 MCI unit/km or 1.1 MCI units/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, rather an improvement (0.9 unit/km), between the upper reach

(Upper Tangahoe Valley Road) and the 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 overall rates of MCI decline over the 2010-2011 period were lower than the average rate for the short monitoring period prior to 2010.

Community composition varied markedly through the upper reach to lower reach length of the stream surveyed. A total of 35 taxa was recorded in spring of which only twelve taxa were present at all three sites (Table 110). These included one 'highly sensitive', seven 'moderately sensitive', and four 'tolerant' taxa with only the one 'moderately sensitive' taxon (elmid beetles) abundant at all three sites. A higher total of 39 taxa was found along the river's length by the summer survey (Table 111) of which twelve taxa were present at all three sites. These included eight of the widespread taxa in spring. Only one 'moderately sensitive' taxon (elmid beetles) and one 'tolerant' taxon (snail (*Potamopyrgus*)) 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 only slightly less 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 incorporated into the SEM programme in 2008 for the purpose of monitoring a newly-developed walkway and associated riparian planting initiatives in the lower reaches of the stream. Consent monitoring 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 2010-2011 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

Thirty surveys have been undertaken in this lower-reach site in the Herekawe Stream between February 1995 and March 2010. 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, together with spring 2010 and summer 2011 reults

Site code	SEM data (1998 to Mar 2010)					2010-2011 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2010		Mar 2011	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HRK000085	30	13-23	18	68-96	87	20	97	17	94

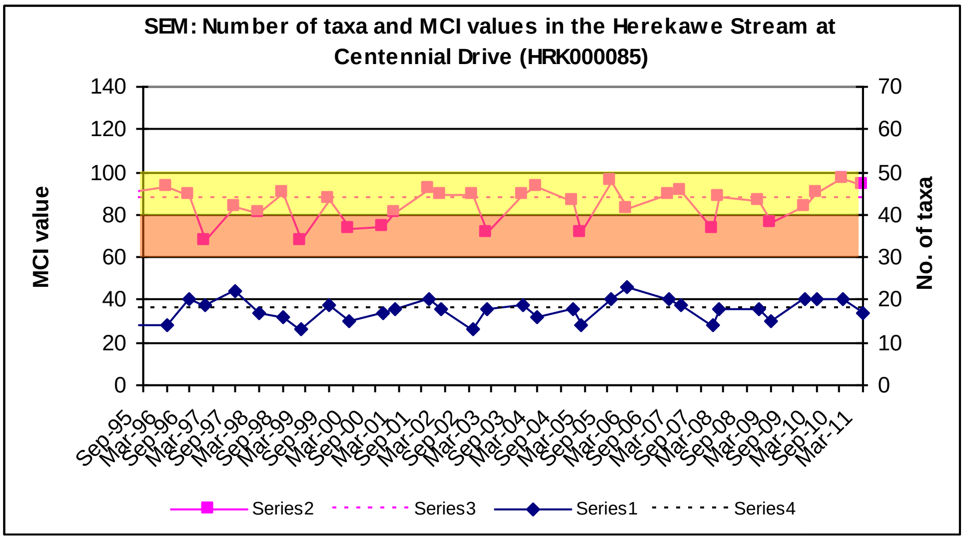


Figure 114 Numbers of taxa and MCI values in the Herekawe Stream upstream of Centennial Drive

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 217 previous surveys of 'control' sites at similar altitudes (TRC, 1999 (updated, 2011)).

During the 2010-2011 period, spring (20 taxa) and summer (17 taxa) richnesses were identical and within two taxa of 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, 2010 (97 units) and summer, 2011 (94 units) scores were typical for such a site. These were 10 and 7 units higher than the historical median in spring and summer respectively.

These scores categorised this site as having 'fair' (spring and summer) health generically (Table 1) and both scores were significantly higher (Stark, 1998) than the median MCI score (75 units) recorded by 217 previous surveys of 'control' sites below 25 m asl in small, coastal ringplain streams in Taranaki (TRC, 1999 (updated, 2011)). 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 2010-2011 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 2010 [30 surveys], and by the spring 2010 and summer 2011 surveys

Taxa List		MCI Score	Total abundances	% of Surveys	Surveys	
					Spring 2010	Summer 2011
ANNELIDA	Oligochaeta	1	19	63	A	A
MOLLUSCA	*Potamopyrgus*	4	30	100	VA	VA
CRUSTACEA	Ostracoda	1	2	7		
	Paracalliope	5	24	80	A	XA
EPHEMEROPTERA	*Austroclima*	7	2	7		
	Coloburiscus	7	2	7		
PLECOPTERA	*Acroperla*	5	1	3		
TRICHOPTERA	*Oxyethira*	2	9	30		
	Triplectides	5	11	37		A
DIPTERA	*Aphrophila*	5	2	7		
	Orthocladiinae	2	17	57	A	
	Austrosimulium	3	12	40		

Prior to the current 2010-2011 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 the one 'moderately sensitive' taxon (amphipod (*Paracalliope*)) and three 'tolerant' taxa (oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges).

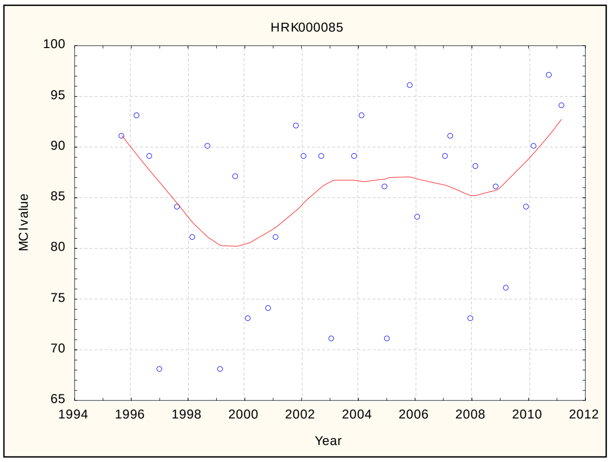
Four of the historically characteristic taxa were dominant in the spring, 2010 community and comprised all four of the predominant taxa (above). The summer, 2011 community was characterised by three of the taxa dominant in spring, together with another one 'moderately sensitive' taxon which previously had been characterisctic of this site's communities (Table 119). A marked increase in the numerical abundance of one individual dominant 'sensitive' taxon (amphipod (*Paracalliope*)) in the summer survey was reflected in the increase in $SQMCI_s$ score (0.9 unit) between seasons (Tables 174 and 175). The two taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 80% 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 2011 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 = 32
Kendall tau = +0.125
p level = 0.313 [>FDR, p = 0.417]
N/S at $p < 0.05$ level

Figure 115 LOWESS trend plot of MCI data at the Centennial Drive site

The slightly positive temporal trend in MCI scores has not been 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 sixteen year period with wide variation in individual MCI scores although the range of LOWESS-smoothed scores (13 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 typically decreased between spring and summer (but only by 3 units) at this lower reach site. The percentage composition of 'tolerant' taxa typically increased by 5% in the summer community when algal mats substrate cover was greater under slightly warmer water temperature conditions. Seasonal communities at this site shared 12 common taxa (48% of the 25 taxa found at this site in 2010-2011)), a moderate percentage of common taxa thereby contributing to the small seasonal difference of 3 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 sixteen years of data available, temporal trend analyses have been updated further within this report. Other comments in relation to the data collected in the period 1995 to 2011, 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 have resulted from the effects of organic enrichment, higher temperatures, increased algal growth (a consequence of the former), and finer substrate (sedimentation) in the lower reaches of streams and rivers.

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 preceding headwater erosion events) but more seasonal variability in richnesses further downstream. Summer richnesses have often 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 generally have had lower summer MCI scores than spring MCI scores as evidenced by decreases in median scores by 3 and 8 units respectively. This difference has been coincident with summer warmer water temperatures and increased periphyton substrate cover, resulting in the loss or replacement of certain 'sensitive' taxa by lower scoring 'tolerant' taxa.

Furthermore, the results from the 2010-2011 period have shown that:

- over all sites, spring MCI scores were slightly higher than summer scores but t-testing of the mean seasonal MCI difference (4 MCI units) showed that this was insignificant ($p = 0.20$)
- at mid reach sites, a decrease in average MCI score of 3 units in summer was insignificant ($p = 0.53$)
- at lower reach sites, a more marked decrease in average MCI score of 7.5 units in summer was significant ($p = 0.02$)
- at all sites, spring 2010 MCI scores were on average 6.3 units higher than long term (fifteen year) median scores, but this difference was not significant at $p = 0.05$ ($p = 0.056$)
- at all sites, summer 2011 MCI scores were on average 2 units higher than long term (fifteen year) median scores, but t-tests showed that this difference was insignificant ($p = 0.53$).

4.1.1 Spring surveys

4.1.1.1 Historical SEM

Fifty-five (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 fifteen sites which were situated in the upper reaches of the Waiwhakaiho River, mid reaches of the Manganui and Stony Rivers, Maketawa, Mangawhero, and Kapoaiaia Streams, and in the lower reaches of the Mangaoraka, Timaru, Waimoku, Kaupokonui, Mangati, Huatoki, and Mangawhero Streams, and Waiwhakaiho and Stony Rivers coincident with lower reach sites having reduced periphyton cover in comparison with many past surveys. Significantly lower scores were not found at any sites.

Figure 116 Spring 2010 MCI scores in relation to SEM historical median values

In summary, 74% of sites showed no significant detectable differences (Stark, 1998) between spring, 2010 MCI scores and historical median scores, while 26% of sites had significantly higher spring 2010 MCI scores, a higher proportion than often found in previous years. No sites had significantly lower spring 2010 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 (three) sites had spring MCI scores more than 5 units below predicted values (Figure 117), one of which (lower reach of the Mangawhero Stream (below the former Eltham WWTP discharge)) was significantly lower than predicted. Twelve sites had spring scores very similar to (within 5 units) predicted scores while the remaining 32 sites' scores were more than 5 MCI units above predicted scores for sites at equivalent altitudes. Of the latter, eighteen sites had significantly higher MCI scores. These sites were situated in the upper reaches of the Waimoku Stream; mid-reaches of the Manganui and Waiwhakaiho Rivers and the Kapoaiaia, Maketawa, Punehu, and Huatoki Streams; and lower reaches of the Mangaoraka, Timaru, Katikara, Huatoki, Waimoku, and Kaupokonui Streams and Stony and Waiwhakaiho Rivers.

Figure 117 Spring 2010 MCI scores in relation to predicted altitude scores.

In summary, 60% of sites showed no significant detectable difference (Stark, 1998) between spring, 2010 scores and predicted altitude scores, while 38% of sites had significantly higher spring, 2010 MCI scores and 2% of sites (one site) had significantly lower spring, 2010 scores.

4.1.1.2.2 Distance from National Park

Only four sites had spring MCI scores more than 5 units below predicted values (Figure 118) with one of these sites significantly lower than predicted. This site was in the Waimoku Stream at the coast (due to the very short distance between the source and the coast). Eight sites had spring scores within 5 MCI units of predicted scores while twenty-six sites' scores were more than 5 units higher than predicted. There were sixteen sites with scores significantly higher than predicted, two of which were in the mid reaches of the Kaupokonui Stream. The other sites were located in the upper reaches of the Patea River; mid reaches of the Waiwhakaiho, Waingongoro, Patea, Stony, and Manganui Rivers, and Maketawa, Kapoaiaia, and Punehu Streams; and in the lower reaches of the Waiwhakaiho, Stony, and Manganui Rivers.

Figure 118 Spring 2010 MCI scores in relation to predicted downstream distance scores

In summary, 55% sites showed no significant detectable difference (Stark, 1998) between spring, 2010 scores and predicted distance (from the National Park) scores, while 44% of sites had significantly higher spring, 2010 MCI scores and 2% of sites (one site) had significantly lower spring, 2010 scores.

4.1.2 Summer surveys

4.1.2.1 Historical SEM

The majority of sites' (53 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 two sites, while only two sites showed significantly lower MCI scores following summer, relatively low flow conditions in the region.

Figure 119 Summer 2011 MCI scores in relation to SEM historical median values

Significantly higher scores were found in the mid reaches of the Kapoaiaia Stream and in the lower reaches of the Kaupokonui River. Significantly lower scores were found in the lower reaches of the Stony River and Huatoki Stream.

In summary, 93% of sites showed no significant detectable differences (Stark, 1998) between summer, 2011 MCI scores and historical median scores, while 4% of sites had significantly higher summer, 2011 scores.

Far 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. In summer, 12% of sites were 6 or more MCI units lower than historical medians compared to 4% in spring whereas 28% of summer sites' scores were greater than 5 MCI units higher than historical medians compared to 46% of sites 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).

4.1.2.2.1 Altitude

Figure 120 Summer 2011 MCI scores in relation to predicted altitude scores

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 the recently diverted Eltham municipal wastewater point source discharge. Seventeen sites had scores very similar to (within 5 units) predicted scores

(Figure 120), while twenty-two sites' scores were more than 5 MCI units above predicted scores for sites at equivalent altitudes. Eight sites had significantly higher MCI scores and these were situated in the upper reaches of the Waimoku and Timaru Streams; mid reaches of the Huatoki Stream (in the Domain) and Waiwhakaiho and Stony Rivers; and in the lower reaches of the Kaupokonui, Katikara, and Timaru Streams.

In summary, 77% of sites showed no significant detectable difference (Stark, 1998) between summer, 2011 scores and predicted altitude scores, while 17% 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

Only four sites (the same numbers as in spring) had summer MCI score more than 5 units below predicted values (Figure 121) but only one of these sites' scores (in the lower reaches of the Waimoku Stream) was significantly lower than predicted. Eighteen sites had summer scores within 5 units of predicted scores, while sixteen sites' scores (ten fewer than in spring) were more than 5 units higher than predicted. There were eight sites with scores significantly higher than predicted, eight sites fewer than in spring. These sites were situated in the upper reaches of the Patea River and Timaru Stream; mid reaches of the Waiwhakaiho, Mangaui, Patea and Waingongoro Rivers, and Kaupokonui Stream (Figure 121); and lower reaches of the Waingongoro River.

In summary, 76% of sites showed no significant detectable difference (Stark, 1998) between summer, 2011 MCI scores and predicted distance (from National Park) scores, while 21% of sites had significantly higher summer scores and 3% 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.

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 2010			Summer 2011		
Prediction	> 10 units lower	± 10 units	> 10 units higher	> 10 units lower	± 10 units	> 10 units higher
Altitude	2	60	38	6	77	17
Distance	2	55	44	3	76	21

In general, while there was minimal seasonal difference between seasons in sites' percentages of scores falling significantly below predicted scores (up to 4% fewer in spring), there was a marked decrease of 21 to 23% 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.

Figure 121 Summer 2011 MCI scores in relation to predicted downstream distance scores

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). 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 sixteen year duration (1995 to 2011) 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 (1995-2011) 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%	14%	0%	14%	0%	0%
Mid reaches	5%	10%	0%	19%	24%	0%
Lower reaches	5%	10%	20%	0%	40%	0%
All sites	4%	11%	8%	11%	28%	0%

[Notes: Stark and Fowles, 2009[1]; Leathwick[2]]

In summary, 15% of all sites median MCI scores differed significantly from the predictions based upon altitude on the ringplain with the majority of these higher than predicted. 19% of sites' median scores differed significantly from predictions based on distance from the National Park boundary with relatively similar proportions higher and lower than predicted although there were marked downstream differences. No individual site's median MCI score differed significantly from both of the 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, but a significant proportion of lower catchment sites had lower median scores than predicted by distance.

No median MCI scores significantly exceeded predicted scores based upon the REC system, whereas 28% of sites' scores were significantly lower, increasing in a downstream direction from none in the upper reaches through to 40% of sites in the lower reaches. Interestingly, very few sites' median scores exceeded the REC predictions in any reaches (six 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 2010 period) (invariably recorded in spring) have often 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, lower reaches of the Mangaehu River, and mid reaches of the Mangawhero Stream. The proportion of sites where the maximum SEM MCI scores over the sixteen years to date has significantly (11 units or more) exceeded the REC predicted scores (35%) 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 sixteen 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 (1995-2011) 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)
		Waiokura S @ Manaia (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)
		Kaupokonui S @ Skeet Road (l)
		Timaru S @ SH 45 (l)
		Stony R @ Mangatete Road (m)

[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. The Mangaehu River and the two small, non-ringplain sourced streams (Mangati and Mangawhero), which receive significant point source discharges rank poorly in terms of the REC predictions. (Note: these streams and river sites are excluded from the distance predictive rankings as these 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 sixteen year period (1995-2011). 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.

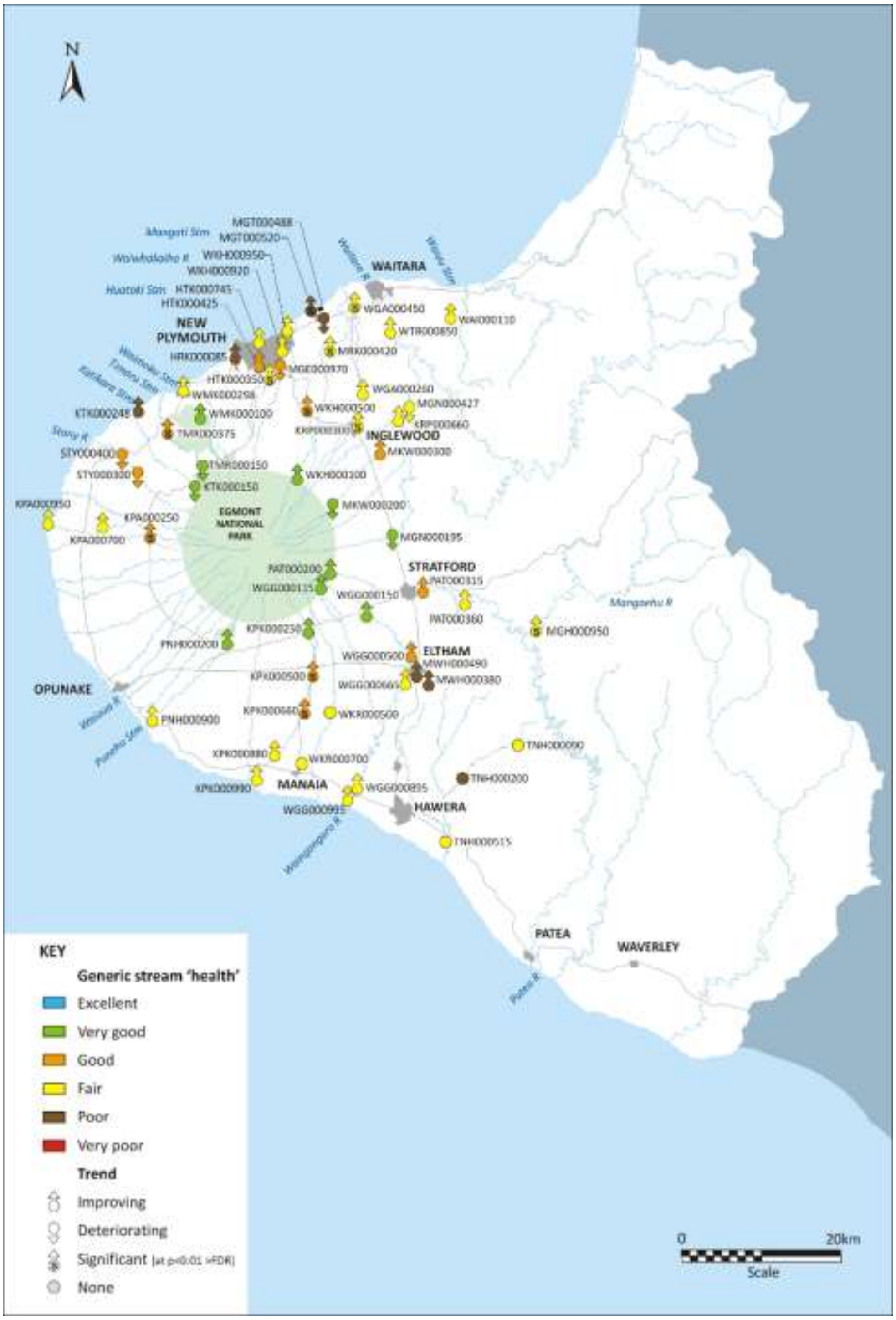


Figure 122 Generic biological 'health' (based on median MCI) and trends in biological quality for SEM sites, 1995 to 2011

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	3	8	9
Expected	4	8	10
Worse than expected	0	0	1
Well below expected	0	0	0
Median ranges (MCI units)	127-138 (11)	89-129 (40)	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 ringplain 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.

4.1.5 Comments

This decreasing gradient of stream 'health', from 'very good' in the upper reaches of ringplain streams to 'fair' in the lower reaches, is indicative of a downstream progression of macroinvertebrate communities towards those that are comprised of taxa more 'tolerant' of organic enrichment and/or physical habitat deterioration in the lower reaches. These communities have become well adapted to the cumulative impacts of upstream point source discharges and non-point source diffuse run-off and are particularly resistant to further impacts (other than toxic discharges). Therefore, while some temporal trends may be detected in these lower reach communities, they are unlikely to be of statistical significance (Figure 22). Thus, while maintenance of ('fair') stream 'health' occurs in the lower reaches of ringplain catchments (as these communities are very 'tolerant' of cumulative organic impacts), temporal trends of improvement in stream 'health' are unlikely to be statistically significant until appropriate management initiatives are substantially progressed on a catchment wide basis. Enhancement of stream health, particularly at sites in the lower reaches of ringplain streams, is unlikely to occur until marked improvements in habitat and water quality occur. These may be implemented for instance by way of a combination of riparian fencing/planting initiatives and re-direction of dairy pond treatment system discharges from direct disposal into surface waters to irrigation to land.

4.2 Macroinvertebrate fauna MCI trends

Temporal trends measured over the monitoring period between 1995 and 2011 (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 (1995-2011) for 52 Taranaki streams/rivers (p without FDR applied)

Site code	N	p-level	+/-(ve)	Significance
STY000300	35	0.159	-ve	N/S
STY000400	35	0.289	-ve	N/S
TMR000150	32	0.482	-ve	N/S
TMR000375	32	<0.0001	+ve	signif*
MRK000420	32	<0.0001	+ve	signif*
WGA000260	33	0.224	+ve	N/S
WGA000450	32	<0.0002	+ve	signif*
WKH000100	18	0.939	-ve	N/S
WKH000500	32	0.028	+ve	signif*
WKH000920	33	0.246	+ve	N/S
WKH000950	31	0.218	+ve	N/S
MGE000970	18	0.444	-ve	N/S
MGN000195	34	0.101	-ve	N/S
MGN000427	32	0.869	-ve	N/S
MKW000200	23	0.095	-ve	N/S
MKW000300	22	0.776	+ve	N/S
WTR000850	32	0.045	+ve	signif
MGT000488	33	0.454	-ve	N/S
MGT000520	33	0.004	+ve	signif
WMK000100	24	0.701	+ve	N/S
WMK000298	24	0.051	+ve	N/S
WAI000110	25	0.020	+ve	signif
PNH000200	32	0.089	+ve	N/S
PNH000900	32	0.003	+ve	signif
PAT000200	32	0.483	+ve	N/S
PAT000315	32	0.216	+ve	N/S
PAT000360	32	0.366	+ve	N/S
MGH000950	32	<0.0001	+ve	signif*
WGG000115	33	0.096	+ve	N/S
WGG000150	33	0.786	+ve	N/S
WGG000500	35	0.010	+ve	signif
WGG000665	32	0.085	+ve	N/S
WGG000895	33	0.205	+ve	N/S
WGG000995	32	0.087	+ve	N/S
MWH000380	32	0.028	+ve	signif
MWH000490	32	0.036	+ve	signif
HTK000350	30	<0.0001	+ve	signif*
HTK000425	30	0.006	+ve	signif
HTK000745	30	0.647	+ve	N/S
KPK000250	25	0.409	+ve	N/S
KPK000500	28	0.001	+ve	signif*
KPK000660	32	<0.0001	+ve	signif*
KPK000880	32	0.034	+ve	signif
KPK000990	24	0.040	+ve	signif
KTK000150	24	0.376	-ve	N/S
KTK000248	23	0.033	+ve	signif
KPA000250	24	<0.0001	+ve	signif*
KPA000700	24	0.005	+ve	signif
KPA000950	24	0.227	+ve	N/S
KRP000300	33	<0.0001	+ve	signif*
KRP000660	33	0.005	+ve	signif
WKR000500	-	-	-	-
WKR000700	-	-	-	-
TNH000090	-	-	-	-
TNH000200	-	-	-	-
TNH000515		-	-	-
HRK000085	32	0.313	+ve	N/S

[N/S = not statistically significant (ie p≥0.05); * = significant after FDR applied; -ve = negative trend, +ve = positive trend]

The majority of these trends were not statistically significant for the monitoring period (see also Appendix II). The following is a summary of significant trends for the SEM period to date:

- nine sites with a positive very significant trend ($p \leq 0.01$ after FDR)
- fourteen 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 1995-2011 [significant trend at $p<0.05$ and $p<0.01$]

Site	Valid N	p-level	p-value (FDR corrected)	Ecological significance (LOWESS-smoothed range)
KPK000660	32	<0.0001	<0.0001	very high, 30 units
KRP000300	33	<0.0001	<0.0001	moderate, 14 units
TMR000375	32	<0.0001	<0.0001	high, 24 units
MRK000420	32	<0.0001	<0.0001	high, 21 units
MGH000950	32	<0.0001	0.0001	moderate, 15 units
KPA000250	24	0.0001	0.0011	very high, 33 units
WGA000450	32	0.0001	0.0011	moderate, 18 units
HTK000350	30	0.0004	0.002	moderate, 14 units
KPK000500	28	0.0010	0.006	high, 22 units
PNH000900	32	0.0039	0.020	moderate, 16 units
MGT000520	33	0.0043	0.020	moderate,19 units
KRP000660	33	0.0051	0.022	high, 20 units
KPA000700	24	0.0054	0.022	high, 25 units
HTK000425	30	0.0065	0.024	low, 9 units
WGG000500	35	0.0099	0.034	low, 7 units
WAI000110	25	0.0203	0.066	moderate, 11 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 16 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.

Three of these sites have illustrated particularly strong improvments over the most recent four to five year period.

Slightly lower positive temporal improvements, but very significant ecological variability have been shown at the following sites:

- Kaupokonui Stream upstream of Kaponga WWTP
- Mangati Stream at Bell Block
- Kurapete Stream 6 km downstream of Inglewood WWTP
- Mangaehu Road at Raupuha Road
- Kurapete Stream upstream of Inglewood WWTP
- Waiongana Stream at SH3

5. Summary

These sixteenth spring and summer biomonitoring components of the established SEM programme were performed during the period from mid October 2010 to mid November 2010 and early February to mid March 2011. 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, 2011) 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 sixteen 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.

Temporal enhancement of stream 'health', particularly in the lower reaches of ringplain catchments (currently in 'fair' condition), may not be expected to be significant until upstream initiatives (such as diversion to land irrigation of dairy shed wastes and riparian planting/fencing) are substantially implemented throughout catchments.

6. Recommendations from the 2009-2010 report

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 be updated on an annual basis.

The programme followed Recommendation 1 in the 2010-2011 monitoring year (with no additional sites required) and the temporal trend reporting was undertaken and included in the Annual Report.

7. Recommendations for 2011-2012

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2011-2012 monitoring year by means of a similar programme to that undertaken in 2010-2011.
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

8. Acknowledgements

The Job Manager for the programme was Chris Fowles (Scientific Officer) who was the author of this Annual Report. Statistical analyses were provided by Alex Connolly (Scientific Officer) with all field sample collection performed by Chris Fowles and Bart Jansma (Scientific Officers). Macroinvertebrate sample processing was undertaken by Biosortid Ltd. with appropriate quality control procedures initiated and reported by Taranaki Regional Council.

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Appendix I

Macroinvertebrate faunal tables

Table 126 Macroinvertebrate fauna of the Stony River: spring SEM survey sampled on 28 October 2010

Taxa List	Site Code / Sample Number	MCI score	TMR000150	TMR000375
	Sample Number		FWB10322	FWB10323
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	C	C
COLEOPTERA (BEETLES)	Elmidae	6	-	R
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	R	-
	Pycnocentrodes	5	R	-
DIPTERA (TRUE FLIES)	Eriopterini	5	R	R
		No of taxa	4	3
		MCI	125	127
		SQMCIs	7.1	7.3
		EPT (taxa)	3	1
		%EPT (taxa)	75	33
'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 23 February 2011

Taxa List	Site Code / Sample Number	MCI score	STY000300	STY000400
	Sample Number		FWB11103	FWB11104
MOLLUSCA	*Potamopyrgus*	4	R	-
CRUSTACEA	Talitridae	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	VA	XA
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	A	C
HEMIPTERA (BUGS)	*Saldula*	5	R	-
COLEOPTERA (BEETLES)	Elmidae	6	R	-
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	C
	Costachorema	7	C	R
	Hydrobiosis	5	-	C
	Plectrocnemia	8	R	-
	Psilochorema	6	R	R
DIPTERA (TRUE FLIES)	Eriopterini	5	C	R
	Maoridiamesa	3	-	R
	Orthocladiinae	2	C	C
	Polypedilum	3	-	R
	Tanytarsini	3	-	R
	Empididae	3	-	R
		No of taxa	11	13
		MCI	115	95
		SQMCIs	7.5	7.8
		EPT (taxa)	6	6
		%EPT (taxa)	55	46
'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 28 October 2010

Taxa List	Site Code	MCI score	TMR000150	TMR000375
	Sample Number		FWB10324	FWB10325
ANNELIDA (WORMS)	Oligochaeta	1	R	-
MOLLUSCA	*Latia*	5	-	R
	Potamopyrgus	4	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	A
	Coloburiscus	7	A	VA
	Deleatidium	8	XA	VA
	Nesameletus	9	VA	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	R
	Austroperla	9	C	-
	Megaleptoperla	9	R	-
	Stenoperla	10	R	-
	Zelandobius	5	A	A
	Zelandoperla	8	XA	A
COLEOPTERA (BEETLES)	Elmidae	6	C	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	VA
	Costachorema	7	C	-
	Hydrobiosis	5	C	-
	Hydrobiosella	9	C	-
	Neurochorema	6	-	R
	Orthopsyche	9	C	-
	Beraeoptera	8	A	XA
	Confluens	5	-	R
	Olinga	9	-	R
	Pycnocentrodes	5	R	VA
	Zelolessica	7	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A
	Eriopterini	5	C	C
	Maoridiamesa	3	R	R
	Orthocladiinae	2	C	C
	Polypedilum	3	-	R
	Tanytarsini	3	R	-
		No of taxa	26	22
		MCI	125	115
		SQMCIs	7.9	7.0
		EPT (taxa)	18	13
		%EPT (taxa)	69	59
'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 23 February 2011

Taxa List	Site Code / Sample Number	MCI score	TMR000150 FWB11105	TMR000375 FWB11106
ANNELIDA (WORMS)	Oligochaeta	1	-	A
MOLLUSCA	*Potamopyrgus*	4	-	C
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	R	-
	Ameletopsis	10	R	-
	Austroclima	7	-	C
	Coloburiscus	7	VA	A
	Deleatidium	8	XA	C
	Nesameletus	9	VA	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	R
	Megaleptoperla	9	C	-
	Stenoperla	10	C	-
	Zelandobius	5	A	R
	Zelandoperla	8	VA	A
COLEOPTERA (BEETLES)	Elmidae	6	C	A
	Hydraenidae	8	R	-
	Ptilodactylidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	VA
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	VA
	Costachorema	7	C	C
	Hydrobiosis	5	R	C
	Hydrobiosella	9	C	-
	Neurochorema	6	-	C
	Orthopsyche	9	C	-
	Polyplectropus	6	R	-
	Beraeoptera	8	A	VA
	Olinga	9	-	R
	Pycnocentrodes	5	-	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	VA
	Eriopterini	5	R	C
	Harrisius	6	-	C
	Maoridiamesa	3	-	C
	Orthocladiinae	2	VA	A
	Tanytarsini	3	-	C
	Empididae	3	-	R
	Austrosimulium	3	-	R
	Tanyderidae	4	-	R
		No of taxa	23	28
		MCI	143	112
		SQMCIs	7.3	5.6
		EPT (taxa)	17	14
		%EPT (taxa)	74	50
'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 12 October 2010

Taxa List	Site Code	MCI score	MRK000420
	Sample Number		FWB10294
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Latia*	5	C
	Potamopyrgus	4	A
CRUSTACEA	*Paratya*	3	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A
	Coloburiscus	7	C
	Deleatidium	8	A
	Nesameletus	9	R
	Zephlebia group	7	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R
	Zelandobius	5	A
COLEOPTERA (BEETLES)	Elmidae	6	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A
	Costachorema	7	C
	Hydrobiosis	5	C
	Neurochorema	6	R
	Pycnocentria	7	C
	Pycnocentrodes	5	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C
	Maoridiamesa	3	R
	Orthocladiinae	2	C
	Tanytarsini	3	C
	Empididae	3	R
		No of taxa	24
		MCI	103
		SQMCIs	5.5
		EPT (taxa)	13
		%EPT (taxa)	54
'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 7 February 2011

Taxa List	Site Code	MCI score	MRK000420
	Sample Number		FWB11035
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R
NEMERTEA	Nemertea	3	C
ANNELIDA (WORMS)	Oligochaeta	1	C
MOLLUSCA	*Latia*	5	R
	Potamopyrgus	4	XA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA
	Coloburiscus	7	C
	Deleatidium	8	C
COLEOPTERA (BEETLES)	Elmidae	6	XA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	XA
	Costachorema	7	C
	Hydrobiosis	5	VA
	Neurochorema	6	C
	Oxyethira	2	R
	Pycnocentria	7	C
	Pycnocentrodes	5	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A
	Maoridiamesa	3	A
	Orthocladiinae	2	A
	Tanytarsini	3	A
	Dolichopodidae	3	R
	Empididae	3	C
	Muscidae	3	C
	Austrosimulium	3	C
		No of taxa	25
		MCI	90
		SQMCIs	4.8
		EPT (taxa)	9
		%EPT (taxa)	36
'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 8 November 2010

Taxa List	Site Code	MCI score	WGA000260	WGA000450
	Sample Number		FWB10368	FWB10369
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	C	A
MOLLUSCA	*Potamopyrgus*	4	R	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	C
	Coloburiscus	7	R	-
	Deleatidium	8	VA	A
PLECOPTERA (STONEFLIES)	*Stenoperla*	10	R	-
	Zelandobius	5	-	A
	Zelandoperla	8	-	R
COLEOPTERA (BEETLES)	Elmidae	6	A	VA
	Hydraenidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	A
	Costachorema	7	C	R
	Hydrobiosis	5	C	R
	Neurochorema	6	-	R
	Oxyethira	2	-	R
	Pycnocentria	7	-	R
	Pycnocentrodes	5	C	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	C
	Eriopterini	5	R	-
	Maoridiamesa	3	A	A
	Orthocladiinae	2	XA	VA
	Tanypodinae	5	R	-
	Tanytarsini	3	C	R
	Empididae	3	-	R
	Muscidae	3	R	R
	Psychodidae	1	R	-
	Austrosimulium	3	R	R
		No of taxa	22	22
		MCI	95	95
		SQMCIs	3.2	4.2
		EPT (taxa)	7	10
		%EPT (taxa)	32	45
'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 24 February 2011

Taxa List	Site Code	MCI score	WGA000260	WGA000450
	Sample Number		FWB11119	FWB11120
NEMERTEA	Nemertea	3	-	C
NEMATODA	Nematoda	3	C	-
ANNELIDA (WORMS)	Oligochaeta	1	C	VA
	Lumbricidae	5	R	R
MOLLUSCA	*Latia*	5	-	C
	Potamopyrgus	4	A	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	C
	Coloburiscus	7	C	-
	Deleatidium	8	VA	C
	Nesameletus	9	C	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
	Hydraenidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	VA
	Costachorema	7	C	-
	Hydrobiosis	5	A	C
	Neurochorema	6	R	C
	Confluens	5	C	-
	Oxyethira	2	C	-
	Pycnocentria	7	R	R
	Pycnocentrodes	5	A	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	C
	Maoridiamesa	3	C	C
	Orthocladiinae	2	VA	VA
	Tanytarsini	3	VA	A
	Empididae	3	C	C
	Ephydridae	4	R	-
	Muscidae	3	C	R
	Austrosimulium	3	R	C
	Tanyderidae	4	-	R
		No of taxa	27	21
		MCI	98	90
		SQMCIs	4.8	3.6
		EPT (taxa)	11	6
		%EPT (taxa)	41	29
'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 2 November 2010

Taxa List	Site Code	MCI score	WKH000100	WKH000500	WKH000920	WKH000950
	Sample Number		FWB10327	FWB10328	FWB10330	FWB10332
NEMATODA	Nematoda	3	-	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	-	-	C	R
MOLLUSCA	*Potamopyrgus*	4	-	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	-	-	R
	Coloburiscus	7	R	C	C	C
	Deleatidium	8	VA	XA	VA	XA
	Nesameletus	9	C	R	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	-	-	-	R
	Austroperla	9	R	-	-	-
	Megaleptoperla	9	R	-	R	R
	Zelandobius	5	-	-	R	-
	Zelandoperla	8	A	C	R	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	A	A	C
	Hydraenidae	8	-	-	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	-	R	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	R	C	C
	Costachorema	7	C	C	C	C
	Hydrobiosis	5	R	C	-	-
	Hydrobiosella	9	R	-	-	-
	Hydrochorema	9	R	-	-	-
	Plectrocnemia	8	-	-	-	R
	Psilochorema	6	C	R	-	-
	Beraeoptera	8	A	C	R	R
	Helicopsyche	10	-	R	-	-
	Olinga	9	R	-	-	-
	Pycnocentrodes	5	-	C	C	-
	Zelolessica	7	R	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C	C	C
	Eriopterini	5	C	C	-	-
	Maoridiamesa	3	R	C	R	A
	Orthocladiinae	2	-	VA	A	A
	Tanytarsini	3	-	C	-	R
	Empididae	3	-	-	-	R
	Ephydridae	4	-	-	-	R
	Muscidae	3	-	-	-	R
	Austrosimulium	3	-	-	-	R
		No of taxa	19	17	16	24
		MCI	140	119	110	105
		SQMCIs	7.1	6.9	6.5	7.4
		EPT (taxa)	15	11	9	10
		%EPT (taxa)	79	65	56	42
'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 1 March, 2011

Taxa List	Site Code	MCI score	WKH000100	WKH000500	WKH000920	WKH000950
	Sample Number		FWB11131	FWB11132	FWB11133	FWB11135
NEMERTEA	Nemertea	3	-	-	R	C
NEMATODA	Nematoda	3	-	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	-	-	C	A
	Lumbricidae	5	R	R	R	-
MOLLUSCA	*Potamopyrgus*	4	-	-	R	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R	A	-
	Coloburiscus	7	R	C	R	-
	Deleatidium	8	XA	XA	A	R
	Nesameletus	9	C	R	-	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	R	-	-
	Megaleptoperla	9	C	R	-	-
	Zelandoperla	8	VA	C	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	A	A
	Hydraenidae	8	-	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	VA	VA	XA
	Costachorema	7	R	A	R	R
	Hydrobiosis	5	R	A	R	R
	Neurochorema	6	-	R	-	-
	Orthopsyche	9	C	-	-	-
	Polyplectropus	6	-	R	-	-
	Psilochorema	6	R	-	-	-
	Oxyethira	2	-	-	C	A
	Pycnocentrodes	5	-	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	VA	-	R
	Eriopterini	5	C	C	-	R
	Maoridiamesa	3	-	VA	-	-
	Orthocladiinae	2	R	VA	VA	VA
	Tanytarsini	3	R	C	C	A
	Empididae	3	-	R	R	R
	Muscidae	3	-	C	C	R
	Tanyderidae	4	-	-	R	-
		No of taxa	17	24	19	17
		MCI	126	117	88	84
		SQMCIs	7.6	6.0	3.9	3.6
		EPT (taxa)	11	13	6	4
		%EPT (taxa)	65	54	32	24
'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 2 November 2010

Taxa List	Site Code	MCI score	MGE000970
	Sample Number		FWB10329
NEMERTEA	Nemertea	3	R
NEMATODA	Nematoda	3	R
ANNELIDA (WORMS)	Oligochaeta	1	C
MOLLUSCA	*Latia*	5	R
	Potamopyrgus	4	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A
	Coloburiscus	7	C
	Deleatidium	8	A
	Ichthybotus	8	R
	Zephlebia group	7	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C
	Zelandobius	5	A
	Zelandoperla	8	R
COLEOPTERA (BEETLES)	Elmidae	6	A
	Hydraenidae	8	R
	Ptilodactylidae	8	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C
	Costachorema	7	R
	Hydrobiosis	5	C
	Neurochorema	6	C
	Beraeoptera	8	R
	Confluens	5	R
	Oxyethira	2	R
	Pycnocentrodes	5	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A
	Maoridiamesa	3	A
	Orthocladiinae	2	VA
	Tanypodinae	5	R
	Tanytarsini	3	A
	Empididae	3	C
	Austrosimulium	3	A
		No of taxa	32
		MCI	104
		SQMCIs	4.1
		EPT (taxa)	15
		%EPT (taxa)	47
'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 1 March 2011

Taxa List	Site Code	MCI score	MGE000970
	Sample Number		**FWB11130**
NEMERTEA	Nemertea	3	C
NEMATODA	Nematoda	3	R
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Latia*	5	R
	Potamopyrgus	4	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A
	Coloburiscus	7	R
	Deleatidium	8	C
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	R
COLEOPTERA (BEETLES)	Elmidae	6	A
	Ptilodactylidae	8	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA
	Costachorema	7	R
	Hydrobiosis	5	A
	Neurochorema	6	R
	Oxyethira	2	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R
	Orthocladiinae	2	VA
	Tanytarsini	3	VA
	Empididae	3	A
	Muscidae	3	C
	Austrosimulium	3	A
		No of taxa	23
		MCI	96
		SQMCIs	3.5
		EPT (taxa)	8
		%EPT (taxa)	35
'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 8 November 2010

Taxa List	Site Code / Sample Number	MCI score	MGN000195	MGN000427
			FWB10370	FWB10371
NEMATODA	Nematoda	3	-	R
MOLLUSCA	*Potamopyrgus*	4	-	R
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	C	A
	Deleatidium	8	VA	XA
	Nesameletus	9	R	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	-
	Austroperla	9	R	-
	Megaleptoperla	9	R	-
	Zelandoperla	8	A	R
COLEOPTERA (BEETLES)	Elmidae	6	A	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	R
	Costachorema	7	R	C
	Hydrobiosis	5	R	-
	Psilochorema	6	R	-
	Beraeoptera	8	R	-
	Olinga	9	R	R
	Pycnocentrodes	5	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C
	Eriopterini	5	C	R
	Maoridiamesa	3	-	A
	Orthocladiinae	2	R	XA
	Tanytarsini	3	-	R
	Empididae	3	-	R
		No of taxa	19	17
		MCI	131	109
		SQMCIs	7.3	5.0
		EPT (taxa)	14	7
		%EPT (taxa)	74	41
'Tolerant' taxa	'Moderately sensitive' taxa		'Highly sensitive' taxa	

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 139 Macroinvertebrake fauna of the Manganui River: summer SEM survey sampled on 24 February 2011

Taxa List	Site Code	MCI score	MGN000195	MGN000427
	Sample Number		FWB11115	FWB11116
NEMATODA	Nematoda	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	R	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R
	Coloburiscus	7	C	-
	Deleatidium	8	VA	XA
	Nesameletus	9	A	C
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-
	Zelandobius	5	R	-
	Zelandoperla	8	A	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	VA
	Costachorema	7	R	C
	Hydrobiosis	5	R	A
	Neurochorema	6	-	R
	Psilochorema	6	C	-
	Olinga	9	R	-
	Oxyethira	2	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	A	-
	Maoridiamesa	3	-	R
	Orthocladiinae	2	R	VA
	Tanytarsini	3	-	R
	Empididae	3	-	C
	Muscidae	3	-	C
		No of taxa	17	19
		MCI	121	97
		SQMCIs	6.9	6.4
		EPT (taxa)	11	8
		%EPT (taxa)	65	42
'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 8 November 2010

Taxa List	Site Code	MCI score	MKW000200	MKW000300
	Sample Number		FWB10372	FWB10373
ANNELIDA (WORMS)	Lumbricidae	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	R	A
	Deleatidium	8	VA	XA
	Nesameletus	9	A	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R
	Austroperla	9	R	-
	Megaleptoperla	9	R	R
	Zelandobius	5	-	R
	Zelandoperla	8	A	R
COLEOPTERA (BEETLES)	Elmidae	6	A	C
	Hydrophilidae	5	R	-
	Staphylinidae	5	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	C
	Costachorema	7	C	C
	Hydrobiosis	5	R	-
	Neurochorema	6	-	R
	Psilochorema	6	C	R
	Beraeoptera	8	A	R
	Olinga	9	R	-
	Pycnocentrodes	5	R	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	C	C
	Maoridiamesa	3	R	C
	Orthocladiinae	2	-	VA
	Tanytarsini	3	-	C
	Austrosimulium	3	-	R
		No of taxa	20	21
		MCI	129	115
		SQMCIs	7.6	6.8
		EPT (taxa)	13	13
		%EPT (taxa)	65	62
'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 24 February 2011

Taxa List	Site Code	MCI score	MKW000200	MKW000300
	Sample Number		FWB11117	FWB11118
ANNELIDA (WORMS)	Oligochaeta	1	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	C
	Coloburiscus	7	R	A
	Deleatidium	8	XA	XA
	Nesameletus	9	VA	A
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-
	Megaleptoperla	9	R	-
	Stenoperla	10	-	R
	Zelandoperla	8	VA	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	VA
	Costachorema	7	C	A
	Hydrobiosis	5	C	A
	Neurochorema	6	R	-
	Polyplectropus	6	R	R
	Psilochorema	6	R	R
	Olinga	9	R	-
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	VA
	Eriopterini	5	C	C
	Maoridiamesa	3	R	A
	Orthocladiinae	2	C	A
	Polypedilum	3	R	-
	Tanypodinae	5	-	R
	Tanytarsini	3	-	C
	Empididae	3	R	R
	Muscidae	3	R	R
	Austrosimulium	3	-	R
		No of taxa	21	24
		MCI	117	107
		SQMCIs	7.7	6.7
		EPT (taxa)	13	12
		%EPT (taxa)	62	50
'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 8 November 2010

Taxa List	Site Code	MCI score	WTR000850
	Sample Number		FWB10374
NEMATODA	Nematoda	3	R
ANNELIDA (WORMS)	Oligochaeta	1	C
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	R
	Deleatidium	8	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R
COLEOPTERA (BEETLES)	Elmidae	6	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C
	Costachorema	7	R
	Neurochorema	6	R
	Pycnocentrodes	5	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C
	Maoridiamesa	3	R
	Orthocladiinae	2	A
	Tanytarsini	3	C
	Austrosimulium	3	R
		No of taxa	15
		MCI	91
		SQMCIs	6.4
		EPT (taxa)	7
		%EPT (taxa)	47
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa	

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 143 Macroinvertebrate fauna of the Waitara River: summer SEM survey sampled on 24 February 2011

Taxa List	Site Code	MCI score	WTR000850
	Sample Number		FWB11121
NEMATODA	Nematoda	3	R
ANNELIDA (WORMS)	Oligochaeta	1	A
	Lumbricidae	5	R
MOLLUSCA	*Potamopyrgus*	4	R
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	A
COLEOPTERA (BEETLES)	Elmidae	6	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C
	Hydrobiosis	5	R
	Oxyethira	2	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R
	Orthocladiinae	2	VA
	Tanytarsini	3	C
	Empididae	3	R
	Muscidae	3	R
	Tanyderidae	4	R
		No of taxa	15
		MCI	77
		SQMCIs	2.8
		EPT (taxa)	3
		%EPT (taxa)	20
'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 13 October 2010

Taxa List	Site Code	MCI score	MGT000488	MGT000520
	Sample Number		FWB10300	FWB10306
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	A	VA
MOLLUSCA	*Potamopyrgus*	4	A	VA
CRUSTACEA	Isopoda	5	R	-
	Paracalliope	5	R	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	-
DIPTERA (TRUE FLIES)	Orthocladiinae	2	VA	A
	Polypedilum	3	R	R
	Austrosimulium	3	R	-
		No of taxa	9	5
		MCI	69	52
		SQMCIs	2.2	2.5
		EPT (taxa)	1	0
		%EPT (taxa)	11	0
'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 21 March 2011

Taxa List	Site Code	MCI score	MGT000488	MGT000520
	Sample Number		FWB11148	FWB11154
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R	-
NEMERTEA	Nemertea	3	R	C
ANNELIDA (WORMS)	Oligochaeta	1	A	XA
	Lumbricidae	5	-	R
HIRUDINEA (LEECHES)	Hirudinea	3	C	R
MOLLUSCA	*Physa*	3	R	-
	Potamopyrgus	4	VA	XA
	Sphaeriidae	3	R	-
CRUSTACEA	Isopoda	5	C	R
	Paracalliope	5	A	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	-
COLEOPTERA (BEETLES)	Staphylinidae	5	R	-
TRICHOPTERA (CADDISFLIES)	*Psilochorema*	6	R	-
	Triplectides	5	-	C
DIPTERA (TRUE FLIES)	*Zelandotipula*	6	R	-
	Orthocladiinae	2	C	C
	Austrosimulium	3	C	R
	Tanyderidae	4	-	C
		No of taxa	15	10
		MCI	79	70
		SQMCIs	3.7	2.5
		EPT (taxa)	2	1
		%EPT (taxa)	13	10
'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 28 October 2010

Taxa List	Site Code	MCI score	WMK000100	WMK000298
	Sample Number		FWB10320	FWB10321
ANNELIDA (WORMS)	Oligochaeta	1	-	C
	Lumbricidae	5	R	-
MOLLUSCA	*Potamopyrgus*	4	R	C
CRUSTACEA	*Paranephrops*	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	C
	Coloburiscus	7	VA	A
	Deleatidium	8	VA	A
	Ichthybotus	8	C	-
	Zephlebia group	7	C	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	C
	Austroperla	9	C	-
	Spaniocerca	8	R	R
	Stenoperla	10	C	-
	Zelandobius	5	-	C
	Zelandoperla	8	C	-
COLEOPTERA (BEETLES)	Elmidae	6	C	-
	Ptilodactylidae	8	A	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	R
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	R	R
	Hydrobiosis	5	-	C
	Hydrobiosella	9	C	-
	Hydrochorema	9	R	-
	Orthopsyche	9	VA	R
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	C
	Eriopterini	5	C	-
	Chironomus	1	-	R
	Maoridiamesa	3	-	C
	Orthocladiinae	2	A	VA
	Polypedilum	3	-	C
	Austrosimulium	3	-	A
	Tanyderidae	4	-	R
		No of taxa	22	21
		MCI	139	101
		SQMCIs	7.5	3.8
		EPT (taxa)	14	11
		%EPT (taxa)	64	52
'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 23 February 2011

Taxa List	Site Code	MCI score	WMK000100	WMK000298
	Sample Number		FWB11107	FWB11108
NEMERTEA	Nemertea	3	-	R
NEMATODA	Nematoda	3	R	R
ANNELIDA (WORMS)	Oligochaeta	1	C	A
MOLLUSCA	*Ferrissia*	3	-	R
	Potamopyrgus	4	C	VA
CRUSTACEA	Ostracoda	1	-	R
	Isopoda	5	-	R
	Talitridae	5	C	-
	Paranephrops	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	C	-
	Austroclima	7	A	C
	Coloburiscus	7	VA	A
	Deleatidium	8	VA	-
	Ichthybotus	8	C	-
	Nesameletus	9	R	-
	Zephlebia group	7	A	A
PLECOPTERA (STONEFLIES)	*Austroperla*	9	A	-
	Megaleptoperla	9	R	-
	Stenoperla	10	C	-
	Zelandobius	5	R	R
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	C	-
	Hydraenidae	8	R	-
	Ptilodactylidae	8	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	R
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	R	-
	Hydrobiosis	5	-	A
	Hydrobiosella	9	C	-
	Hydrochorema	9	R	-
	Orthopsyche	9	VA	R
	Psilochorema	6	-	R
	Oxyethira	2	-	C
	Pycnocentrodes	5	-	R
	Triplectides	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	A
	Eriopterini	5	C	-
	Limonia	6	R	-
	Harrisius	6	R	-
	Orthocladiinae	2	C	A
	Polypedilum	3	C	VA
	Empididae	3	R	R
	Muscidae	3	-	R
	Austrosimulium	3	-	A
	Tanyderidae	4	-	R
ACARINA (MITES)	Acarina	5	R	-
		No of taxa	32	25
		MCI	130	86
		SQMCIs	7.6	3.9
		EPT (taxa)	16	9
		%EPT (taxa)	50	36
'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 12 October 2010

Taxa List	Site Code	MCI score	WAI000110
	Sample Number		FWB10295
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R
NEMERTEA	Nemertea	3	R
ANNELIDA (WORMS)	Oligochaeta	1	A
	Lumbricidae	5	R
MOLLUSCA	*Latia*	5	C
	Potamopyrgus	4	A
CRUSTACEA	*Paracalliope*	5	C
	Paratya	3	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA
	Zephlebia group	7	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	A
COLEOPTERA (BEETLES)	Elmidae	6	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A
	Hydrobiosis	5	C
	Hudsonema	6	C
	Pycnocentria	7	A
	Pycnocentrodes	5	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A
	Orthocladiinae	2	C
	Austrosimulium	3	R
		No of taxa	21
		MCI	93
		SQMCIs	5.5
		EPT (taxa)	8
		%EPT (taxa)	38
'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 7 February 2011

Taxa List	Site Code / Sample Number	MCI score	WAI000110 / FWB11034
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R
NEMERTEA	Nemertea	3	C
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Latia*	5	A
	Potamopyrgus	4	VA
CRUSTACEA	*Paracalliope*	5	R
	Paranephrops	5	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA
	Coloburiscus	7	R
	Deleatidium	8	R
	Nesameletus	9	R
	Zephlebia group	7	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C
COLEOPTERA (BEETLES)	Elmidae	6	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA
	Costachorema	7	R
	Hydrobiosis	5	C
	Neurochorema	6	R
	Hudsonema	6	C
	Oxyethira	2	R
	Pycnocentria	7	C
	Pycnocentrodes	5	VA
	Triplectides	5	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A
	Maoridiamesa	3	R
	Orthocladiinae	2	A
	Polypedilum	3	R
	Tanytarsini	3	C
	Austrosimulium	3	R
		No of taxa	30
		MCI	99
		SQMCIs	4.9
		EPT (taxa)	14
		%EPT (taxa)	47
'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 3 November 2010

Taxa List	Site Code	MCI score	PNH000200	PNH000900
	Sample Number		FWB10348	FWB10349
ANNELIDA (WORMS)	Oligochaeta	1	-	A
	Lumbricidae	5	R	R
MOLLUSCA	*Potamopyrgus*	4	R	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	C
	Coloburiscus	7	VA	R
	Deleatidium	8	XA	VA
	Nesameletus	9	VA	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	A
	Austroperla	9	R	-
	Megaleptoperla	9	C	-
	Stenoperla	10	C	-
	Zelandobius	5	R	R
	Zelandoperla	8	A	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
	Hydraenidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	C
	Costachorema	7	A	-
	Hydrobiosis	5	C	-
	Orthopsyche	9	R	-
	Psilochorema	6	C	-
	Beraeoptera	8	XA	-
	Helicopsyche	10	A	-
	Olinga	9	C	-
	Pycnocentrodes	5	A	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C
	Eriopterini	5	C	-
	Chironomus	1	-	R
	Corynoneura	3	-	R
	Maoridiamesa	3	C	-
	Orthocladiinae	2	A	C
	Polypedilum	3	-	R
	Tanytarsini	3	-	C
	Empididae	3	R	-
	Tabanidae	3	R	-
		No of taxa	30	18
		MCI	127	90
		SQMCIs	7.6	6.0
		EPT (taxa)	19	7
		%EPT (taxa)	63	39
'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 24 February 2011

Taxa List	Site Code / Sample Number	MCI score	PNH000200 / FWB11110	PNH000900 / FWB11111
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R
NEMERTEA	Nemertea	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	A
MOLLUSCA	*Potamopyrgus*	4	R	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	A
	Coloburiscus	7	VA	A
	Deleatidium	8	XA	XA
	Nesameletus	9	VA	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-
	Megaleptoperla	9	C	-
	Zelandobius	5	-	R
	Zelandoperla	8	VA	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	XA
	Hydraenidae	8	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	A
	Costachorema	7	C	R
	Hydrobiosis	5	C	C
	Neurochorema	6	R	-
	Psilochorema	6	C	R
	Beraeoptera	8	XA	-
	Olinga	9	C	-
	Pycnocentrodes	5	A	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	VA
	Eriopterini	5	C	-
	Maoridiamesa	3	C	R
	Orthocladiinae	2	A	C
	Polypedilum	3	C	-
	Tanypodinae	5	R	-
	Tanytarsini	3	C	A
	Empididae	3	-	R
	Ephydridae	4	R	-
	Muscidae	3	-	R
	Austrosimulium	3	-	R
	Tanyderidae	4	-	R
		No of taxa	27	24
		MCI	120	93
		SQMCIs	7.6	6.5
		EPT (taxa)	15	9
		%EPT (taxa)	56	38
'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 10 November 2010

Taxa List	Site Code	MCI score	PAT000200	PAT000315	PAT000360
	Sample Number		FWB10384	FWB10385	FWB10390
ANNELIDA (WORMS)	Oligochaeta	1	-	R	C
	Lumbricidae	5	-	-	R
MOLLUSCA	*Potamopyrgus*	4	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C	R
	Coloburiscus	7	A	XA	VA
	Deleatidium	8	XA	XA	XA
	Nesameletus	9	R	C	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	R	-
	Austroperla	9	R	-	-
	Megaleptoperla	9	C	-	-
	Spaniocerca	8	R	-	-
	Stenoperla	10	R	-	-
	Zelandobius	5	A	-	R
	Zelandoperla	8	C	A	-
COLEOPTERA (BEETLES)	Elmidae	6	C	A	VA
	Hydraenidae	8	R	C	R
	Hydrophilidae	5	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	A	A
	Costachorema	7	C	C	A
	Hydrobiosis	5	-	-	A
	Hydrobiosella	9	R	-	-
	Neurochorema	6	-	-	R
	Orthopsyche	9	A	-	-
	Beraeoptera	8	C	A	R
	Confluens	5	R	R	R
	Olinga	9	C	R	-
	Pycnocentria	7	R	-	-
	Pycnocentrodes	5	-	A	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	A
	Eriopterini	5	R	R	C
	Maoridiamesa	3	R	C	XA
	Orthocladiinae	2	A	R	A
	Tanytarsini	3	-	-	C
	Empididae	3	-	-	R
	Austrosimulium	3	-	-	R
		No of taxa	25	20	25
		MCI	138	119	105
		SQMCIs	7.6	7.3	5.6
		EPT (taxa)	18	12	12
		%EPT (taxa)	72	60	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 9 February 2011

Taxa List	Site Code	MCI score	PAT000200	PAT000315	PAT000360
	Sample Number		FWB11036	FWB11037	FWB11042
ANNELIDA (WORMS)	Oligochaeta	1	-	-	A
MOLLUSCA	*Potamopyrgus*	4	-	R	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C	R
	Coloburiscus	7	XA	VA	C
	Deleatidium	8	VA	XA	XA
	Nesameletus	9	A	A	-
	Zephlebia group	7	R	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-	-
	Austroperla	9	C	-	-
	Megaleptoperla	9	A	R	-
	Stenoperla	10	R	-	-
	Taraperla	10	R	-	-
	Zelandobius	5	R	R	-
	Zelandoperla	8	C	R	R
COLEOPTERA (BEETLES)	Elmidae	6	C	A	VA
	Hydraenidae	8	R	C	C
	Hydrophilidae	5	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	VA	VA
	Costachorema	7	R	C	C
	Hydrobiosis	5	R	R	C
	Hydrobiosella	9	C	-	-
	Orthopsyche	9	A	-	-
	Beraeoptera	8	C	-	-
	Confluens	5	C	-	-
	Helicopsyche	10	C	-	-
	Olinga	9	R	C	-
	Oxyethira	2	-	-	R
	Pycnocentria	7	C	-	-
	Pycnocentrodes	5	-	R	R
	Zelolessica	7	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	VA
	Eriopterini	5	R	R	R
	Hexatomini	5	-	-	R
	Maoridiamesa	3	-	R	C
	Orthocladiinae	2	C	A	A
	Polypedilum	3	C	C	-
	Tanytarsini	3	-	-	C
	Empididae	3	-	-	R
	Muscidae	3	-	-	R
	Austrosimulium	3	R	C	C
		No of taxa	31	23	23
		MCI	138	118	97
		SQMCIs	7.2	7.1	6.6
		EPT (taxa)	22	13	8
		%EPT (taxa)	71	57	35
'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 Magaehu River: spring SEM survey sampled on 10 November 2010

Taxa List	Site Code	MCI score	MGH000950
	Sample Number		FWB10393
ANNELIDA (WORMS)	Oligochaeta	1	C
MOLLUSCA	*Potamopyrgus*	4	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A
	Deleatidium	8	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R
COLEOPTERA (BEETLES)	Elmidae	6	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C
	Costachorema	7	C
	Hydrobiosis	5	C
	Pycnocentria	7	R
	Pycnocentrodes	5	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A
	Maoridiamesa	3	A
	Orthocladiinae	2	A
	Polypedilum	3	R
	Tanytarsini	3	C
	Empididae	3	R
	Muscidae	3	C
		No of taxa	19
		MCI	93
		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 155 Macroinvertebrate fauna of the Mangaehu River: summer SEM survey sampled on 9 February 2011

Taxa List	Site Code	MCI score	MGH000950
	Sample Number		FWB11045
ANNELIDA (WORMS)	Oligochaeta	1	R
MOLLUSCA	*Potamopyrgus*	4	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A
	Coloburiscus	7	R
	Deleatidium	8	A
	Zephlebia group	7	A
COLEOPTERA (BEETLES)	Elmidae	6	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A
	Costachorema	7	R
	Hydrobiosis	5	C
	Pycnocentrodes	5	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R
	Orthocladiinae	2	A
	Polypedilum	3	C
	Tanypodinae	5	R
	Tanytarsini	3	A
	Empididae	3	R
	Muscidae	3	C
	Austrosimulium	3	C
		No of taxa	20
		MCI	95
		SQMCIs	5.1
		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 156 Macroinvertebrate fauna of the Waingongoro River: spring SEM survey sampled on 8 November 2010

Taxa List	Site Code	MCI score	WGG000115	WGG000150	WGG000500	WGG000665	WGG000895	WGG000995
	Sample Number		FWB10358	FWB10359	FWB10360	FWB10363	FWB10364	FWB10365
NEMATODA	Nematoda	3	-	-	-	-	R	-
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R	R	A	A
	Lumbricidae	5	-	-	-	-	C	-
MOLLUSCA	*Potamopyrgus*	4	-	-	-	R	A	C
CRUSTACEA	*Paracalliope*	5	-	-	-	-	R	R
	Paratya	3	-	-	-	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	-	R	-	-	-	-
	Austroclima	7	VA	A	-	R	C	R
	Coloburiscus	7	VA	VA	A	R	-	-
	Deleatidium	8	XA	XA	XA	XA	VA	A
	Ichthybotus	8	-	R	-	-	-	-
	Nesameletus	9	A	A	-	-	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	C	-	-	-	-
	Austroperla	9	C	-	-	-	-	-
	Megaleptoperla	9	A	C	-	-	-	-
	Stenoperla	10	R	-	-	-	-	-
	Zelandobius	5	C	-	C	R	C	C
	Zelandoperla	8	VA	A	R	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	VA	VA	A	A
	Hydraenidae	8	C	C	-	-	-	-
	Hydrophilidae	5	R	-	-	-	-	-
	Ptilodactylidae	8	R	-	-	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	C	C	R	-
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	A	A	C	A	A
	Costachorema	7	R	-	C	-	R	R
	Hydrobiosis	5	-	R	R	R	C	R
	Hydrobiosella	9	R	-	-	-	-	-
	Neurochorema	6	-	-	-	-	-	R
	Alloecentrella	8	R	-	-	-	-	-
	Beraeoptera	8	VA	VA	-	R	-	-
	Confluens	5	C	R	-	-	-	-
	Helicopsyche	10	VA	A	-	-	-	-
	Olinga	9	C	C	-	-	-	-
	Pycnocentria	7	C	R	R	-	C	C
	Pycnocentrodes	5	C	C	C	VA	VA	XA
	Triplectides	5	R	-	-	-	-	-
	Zelolessica	7	A	R	-	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	A	R	R	-	R
	Eriopterini	5	R	C	R	-	-	-
	Chironomus	1	-	-	-	-	-	R
	Maoridiamesa	3	C	-	C	A	A	VA
	Orthocladiinae	2	C	R	R	A	A	XA
	Polypedilum	3	-	-	-	-	R	-
	Tanypodinae	5	-	-	R	-	-	-
	Tanytarsini	3	R	-	R	-	R	C
	Empididae	3	-	R	-	-	-	-
	Muscidae	3	R	-	-	-	-	-
	Austrosimulium	3	-	-	-	R	C	-
		No of taxa	33	25	18	17	20	19
		MCI	131	133	103	104	93	92
		SQMCIs	7.5	7.5	7.4	7.0	5.3	3.6
		EPT (taxa)	22	18	9	9	8	9
		%EPT (taxa)	67	72	50	53	40	47
'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 14 February 2011

Taxa List	Site Code	MCI score	WGG000115	WGG000150	WGG000500	WGG000665	WGG000895	WGG000995
	Sample Number		FWB11062	FWB11063	FWB11064	FWB11069	FWB11070	FWB11071
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R	R	A	A
	Lumbricidae	5	-	-	-	-	R	-
MOLLUSCA	*Latia*	5	-	-	-	-	-	R
	Potamopyrgus	4	R	-	R	R	VA	R
CRUSTACEA	*Paracalliope*	5	-	-	-	-	R	-
	Paratya	3	-	-	-	-	-	C
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	-	R	-	-	-	-
	Austroclima	7	A	A	R	R	R	-
	Coloburiscus	7	VA	XA	A	C	R	-
	Deleatidium	8	XA	XA	XA	XA	A	C
	Nesameletus	9	VA	A	-	-	-	-
	Zephlebia group	7	-	R	-	-	R	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-	-	-	-	-
	Megaleptoperla	9	A	C	-	-	-	-
	Stenoperla	10	R	-	-	-	-	-
	Taraperla	10	R	-	-	-	-	-
	Zelandoperla	8	VA	A	-	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	A	XA	VA	VA	C
	Hydraenidae	8	A	C	C	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	A	C	C	-
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	A	VA	A	A	A
	Costachorema	7	-	-	R	C	-	R
	Hydrobiosis	5	C	C	C	C	R	C
	Neurochorema	6	-	-	R	-	-	-
	Orthopsyche	9	R	R	-	-	-	-
	Psilochorema	6	R	R	-	-	-	-
	Beraeoptera	8	VA	VA	-	-	-	-
	Confluens	5	R	R	-	-	-	-
	Helicopsyche	10	C	-	-	-	-	-
	Olinga	9	C	C	-	-	-	-
	Oxyethira	2	R	-	-	-	-	-
	Pycnocentria	7	R	-	-	-	-	-
	Pycnocentrodes	5	C	C	A	VA	VA	VA
	Zelolessica	7	A	R	-	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	VA	C	C	C	R
	Eriopterini	5	-	C	C	-	-	-
	Maoridiamesa	3	C	-	-	A	-	C
	Orthocladiinae	2	A	C	C	VA	C	VA
	Polypedilum	3	R	C	-	R	R	R
	Tanytarsini	3	R	-	R	R	C	C
	Muscidae	3	C	-	-	-	-	-
	Austrosimulium	3	-	C	C	R	C	R
	Tabanidae	3	-	-	R	-	-	-
	Tanyderidae	4	-	-	R	-	-	-
		No of taxa	31	25	20	18	18	16
		MCI	128	130	100	98	97	84
		SQMCIs	7.5	7.2	6.6	6.4	4.8	3.5
		EPT (taxa)	20	17	8	8	7	5
		%EPT (taxa)	65	68	40	44	39	31
'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 8 November 2010

Taxa List	Site Code	MCI score	MWH000380	MWH000490
	Sample Number		FWB10366	FWB10367
NEMERTEA	Nemertea	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	A	A
	Lumbricidae	5	R	C
MOLLUSCA	*Potamopyrgus*	4	-	C
CRUSTACEA	Ostracoda	1	R	-
	Isopoda	5	R	-
	Paracalliope	5	A	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	-
	Deleatidium	8	-	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	C
COLEOPTERA (BEETLES)	Elmidae	6	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	A
	Costachorema	7	-	C
	Hydrobiosis	5	A	C
	Oxyethira	2	C	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	C
	Chironomus	1	R	-
	Maoridiamesa	3	A	VA
	Orthocladiinae	2	A	A
	Austrosimulium	3	-	R
		No of taxa	16	16
		MCI	76	90
		SQMCIs	5.0	4.8
		EPT (taxa)	4	5
		%EPT (taxa)	25	31
'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 11 February 2011

Taxa List	Site Code	MCI score	MWH000380	MWH000490
	Sample Number		FWB11055	FWB11058
NEMERTEA	Nemertea	3	R	R
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	C	VA
	Lumbricidae	5	-	R
MOLLUSCA	*Potamopyrgus*	4	-	VA
CRUSTACEA	Ostracoda	1	-	R
	Paracalliope	5	VA	VA
	Talitridae	5	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	R
	Coloburiscus	7	-	R
	Deleatidium	8	-	VA
COLEOPTERA (BEETLES)	Elmidae	6	R	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	VA
	Hydrobiosis	5	R	A
	Oxyethira	2	C	R
	Pycnocentrodes	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	VA
	Maoridiamesa	3	-	A
	Orthocladiinae	2	A	VA
	Polypedilum	3	-	R
	Tanytarsini	3	-	C
	Muscidae	3	-	C
	Austrosimulium	3	R	R
		No of taxa	12	23
		MCI	77	84
		SQMCIs	4.6	4.1
		EPT (taxa)	3	6
		%EPT (taxa)	25	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 4 November 2010

Taxa List	Site Code	MCI score	HTK000350	HTK000425	HTK000745
	Sample Number		FWB10350	FWB10351	FWB10352
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R	-
NEMATODA	Nematoda	3	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	A	C	VA
	Lumbricidae	5	-	-	R
MOLLUSCA	*Latia*	5	-	-	R
	Potamopyrgus	4	R	R	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A	-
	Coloburiscus	7	A	A	-
	Deleatidium	8	A	VA	C
	Nesameletus	9	A	R	R
	Zephlebia group	7	A	A	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	-	R	-
	Zelandobius	5	A	VA	C
	Zelandoperla	8	C	C	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	VA
	Ptilodactylidae	8	R	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	A	R
	Costachorema	7	A	C	-
	Hydrobiosis	5	C	R	-
	Orthopsyche	9	-	R	-
	Pycnocentrodes	5	R	A	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	R	-
	Eriopterini	5	-	R	R
	Maoridiamesa	3	A	-	-
	Orthocladiinae	2	VA	A	C
	Polypedilum	3	-	-	VA
	Tanypodinae	5	R	-	-
	Tanytarsini	3	R	R	-
	Empididae	3	-	R	-
	Muscidae	3	R	-	-
	Austrosimulium	3	C	A	R
	Tanyderidae	4	-	-	C
		No of taxa	24	25	18
		MCI	104	109	101
		SQMCIs	4.7	5.9	3.7
		EPT (taxa)	11	13	6
		%EPT (taxa)	46	52	33
'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 1 March 2010

Taxa List	Site Code	MCI score	HTK000350	HTK000425	HTK000745
	Sample Number		FWB11127	FWB11128	FWB11129
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	-	C
NEMERTEA	Nemertea	3	-	C	C
NEMATODA	Nematoda	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	C	A	XA
	Branchyura	1	-	-	R
	Lumbricidae	5	-	-	R
MOLLUSCA	*Latia*	5	A	R	-
	Physa	3	-	-	R
	Potamopyrgus	4	C	VA	XA
	Sphaeriidae	3	-	-	R
CRUSTACEA	Ostracoda	1	-	-	A
	Paracalliope	5	-	-	C
	Paratya	3	-	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	VA	-
	Coloburiscus	7	VA	VA	-
	Deleatidium	8	A	A	-
	Nesameletus	9	VA	C	-
	Zephlebia group	7	A	A	-
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	R	-
	Zelandoperla	8	R	C	-
HEMIPTERA (BUGS)	*Saldula*	5	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	VA
	Ptilodactylidae	8	C	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	VA	-
	Costachorema	7	-	R	-
	Hydrobiosis	5	A	C	-
	Neurochorema	6	A	-	-
	Confluens	5	-	C	-
	Oxyethira	2	C	-	R
	Pycnocentria	7	-	R	-
	Pycnocentrodes	5	C	A	A
	Triplectides	5	-	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	R	R
	Eriopterini	5	-	-	R
	Chironomus	1	-	-	C
	Harrisius	6	R	-	-
	Maoridiamesa	3	C	-	-
	Orthocladiinae	2	VA	C	C
	Polypedilum	3	-	R	R
	Tanytarsini	3	VA	R	-
	Ceratopogonidae	3	-	R	-
	Empididae	3	R	R	R
	Ephydridae	4	R	-	-
	Muscidae	3	R	-	-
	Austrosimulium	3	A	A	-
	Tanyderidae	4	-	R	C
		No of taxa	28	28	24
		MCI	101	103	69
		SQMCIs	5.4	5.5	2.8
		EPT (taxa)	11	13	2
		%EPT (taxa)	39	46	8
'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 3 November 2010

Taxa List	Site Code	MCI score	KPK000250	KPK000500	KPK000660	KPK000880	KPK000990
	Sample Number		FWB10345	FWB10346	FWB10339	FWB10342	FWB10347
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	-	-	-	R
NEMATODA	Nematoda	3	-	-	R	R	-
ANNELIDA (WORMS)	Oligochaeta	1	-	-	C	A	VA
	Lumbricidae	5	-	-	-	-	R
MOLLUSCA	*Potamopyrgus*	4	-	-	R	C	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	C	R	R	C
	Coloburiscus	7	A	VA	VA	R	C
	Deleatidium	8	VA	XA	XA	A	VA
	Nesameletus	9	C	A	R	R	-
	Oniscigaster	10	-	R	-	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	C	C	-	R
	Austroperla	9	R	-	-	-	-
	Megaleptoperla	9	C	C	-	-	R
	Stenoperla	10	R	R	-	-	-
	Zelandobius	5	C	R	R	-	C
	Zelandoperla	8	A	C	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	VA	VA	A	VA
	Hydraenidae	8	R	C	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	C	C	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	A	C	A	C
	Costachorema	7	C	R	C	C	C
	Hydrobiosis	5	-	R	R	C	A
	Hydrobiosella	9	R	-	-	-	-
	Neurochorema	6	-	R	-	-	-
	Plectrocnemia	8	-	R	-	-	-
	Beraeoptera	8	VA	XA	A	R	-
	Helicopsyche	10	R	-	-	-	-
	Olinga	9	C	C	R	R	-
	Pycnocentrodes	5	R	VA	VA	VA	XA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	A	C	C	C
	Eriopterini	5	R	C	C	-	-
	Chironomus	1	-	-	-	-	R
	Maoridiamesa	3	C	R	A	VA	VA
	Orthocladiinae	2	R	R	A	A	A
	Polypedilum	3	C	-	-	-	-
	Tanytarsini	3	-	-	C	R	R
	Empididae	3	R	-	-	-	-
	Muscidae	3	-	-	-	-	R
	Austrosimulium	3	-	-	-	-	R
		No of taxa	25	25	22	19	23
		MCI	131	133	107	108	94
		SQMCIs	6.9	7.5	6.9	4.2	4.8
		EPT (taxa)	16	18	12	10	10
		%EPT (taxa)	64	72	55	53	43
'Tolerant' taxa	'Moderately sensitive' taxa		'Highly sensitive' taxa				

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 163 Macroinvertebrate fauna of the Kaupokonui Stream: summer SEM survey sampled on 15 February 2011

Taxa List	Site Code	MCI score	KPK000250	KPK000500	KPK000660	KPK000880	KPK000990
	Sample Number		FWB11084	FWB11085	FWB11090	FWB11093	FWB11088
NEMERTEA	Nemertea	3	-	-	R	-	R
NEMATODA	Nematoda	3	-	-	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	-	R	C	C	VA
	Lumbricidae	5	-	-	R	-	-
MOLLUSCA	*Potamopyrgus*	4	-	-	A	-	-
CRUSTACEA	*Paratya*	3	-	-	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C	A	C	C
	Coloburiscus	7	A	VA	VA	R	-
	Deleatidium	8	XA	XA	XA	VA	A
	Nesameletus	9	VA	VA	R	R	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-	-	-	-
	Megaleptoperla	9	A	C	R	R	-
	Spaniocerca	8	R	-	-	-	-
	Stenoperla	10	R	R	R	-	-
	Taraperla	10	R	-	-	-	-
	Zelandoperla	8	VA	R	-	-	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	XA	A	C
	Hydraenidae	8	R	R	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	R	A	R	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	VA	XA	VA	A
	Costachorema	7	R	C	C	-	R
	Hydrobiosis	5	R	R	C	C	C
	Hydrobiosella	9	R	-	-	-	-
	Psilochorema	6	R	R	R	-	-
	Beraeoptera	8	A	VA	R	-	-
	Olinga	9	C	C	A	-	-
	Pycnocentrodes	5	C	A	R	C	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	VA	A	R	R
	Eriopterini	5	C	C	R	-	-
	Maoridiamesa	3	R	R	R	-	R
	Orthocladiinae	2	C	R	C	A	A
	Polypedilum	3	R	R	R	-	-
	Tanypodinae	5	-	-	R	-	-
	Tanytarsini	3	-	R	R	C	A
	Empididae	3	R	-	-	-	-
	Ephydridae	4	-	R	-	R	R
	Muscidae	3	-	-	-	R	-
	Austrosimulium	3	-	R	R	R	-
ACARINA (MITES)	Acarina	5	-	R	-	-	-
		No of taxa	27	27	27	19	18
		MCI	133	116	110	104	93
		SQMCIs	7.5	7.1	6.1	5.5	3.5
		EPT (taxa)	18	14	13	8	7
		%EPT (taxa)	67	52	48	42	39
'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 4 November 2010

Taxa List	Site Code	MCI score	KTK000150	KTK000248
	Sample Number		FWB10353	FWB10354
ANNELIDA (WORMS)	Oligochaeta	1	-	R
MOLLUSCA	*Potamopyrgus*	4	-	C
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-
	Austroclima	7	-	A
	Coloburiscus	7	C	A
	Deleatidium	8	VA	XA
	Nesameletus	9	A	-
	Zephlebia group	7	-	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	-
	Austroperla	9	R	-
	Stenoperla	10	R	-
	Zelandobius	5	C	A
	Zelandoperla	8	VA	R
COLEOPTERA (BEETLES)	Elmidae	6	C	VA
	Hydraenidae	8	R	-
	Ptilodactylidae	8	-	R
	Staphylinidae	5	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	A
	Costachorema	7	R	A
	Hydrobiosis	5	C	C
	Hydrobiosella	9	R	-
	Orthopsyche	9	R	-
	Plectrocnemia	8	R	-
	Beraeoptera	8	-	R
	Pycnocentria	7	-	R
	Pycnocentrodes	5	R	XA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A
	Eriopterini	5	C	C
	Chironomus	1	-	R
	Maoridiamesa	3	-	C
	Orthocladiinae	2	C	C
	Polypedilum	3	-	R
	Tanytarsini	3	-	C
	Empididae	3	R	R
	Austrosimulium	3	-	C
		No of taxa	23	26
		MCI	135	102
		SQMCIs	7.6	6.3
		EPT (taxa)	15	12
		%EPT (taxa)	65	46
'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 1 March 2011

Taxa List	Site Code	MCI score	KTK000150	KTK000248
	Sample Number		FWB11123	FWB11124
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R
NEMERTEA	Nemertea	3	-	C
ANNELIDA (WORMS)	Oligochaeta	1	-	A
MOLLUSCA	*Latia*	5	-	C
	Potamopyrgus	4	-	XA
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-
	Austroclima	7	-	VA
	Coloburiscus	7	A	A
	Deleatidium	8	A	VA
	Nesameletus	9	A	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-
	Zelandobius	5	C	-
	Zelandoperla	8	VA	-
COLEOPTERA (BEETLES)	Elmidae	6	-	XA
	Hydraenidae	8	-	R
	Ptilodactylidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	VA
	Costachorema	7	C	R
	Hydrobiosis	5	-	A
	Orthopsyche	9	R	-
	Psilochorema	6	R	-
	Olinga	9	-	R
	Pycnocentrodes	5	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	R	R
	Maoridiamesa	3	-	R
	Orthocladiinae	2	C	VA
	Polypedilum	3	A	R
	Tanytarsini	3	-	C
	Empididae	3	-	R
	Austrosimulium	3	-	R
	Tanyderidae	4	-	C
		No of taxa	15	27
		MCI	133	101
		SQMCIs	7.2	5.1
		EPT (taxa)	10	9
		%EPT (taxa)	67	33
'Tolerant' taxa	'Moderately sensitive' taxa		'Highly sensitive' taxa	

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 166 Macroinvertebrate fauna of the Kapoaiaia Stream: spring SEM survey sampled on 4 November 2010

Taxa List	Site Code	MCI score	KPA000250	KPA000700	KPA000950
	Sample Number		FWB10355	FWB10356	FWB10357
NEMATOMORPHA	Nematomorpha	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	R	VA
	Lumbricidae	5	-	R	-
MOLLUSCA	*Potamopyrgus*	4	-	R	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R	A
	Coloburiscus	7	VA	A	R
	Deleatidium	8	XA	XA	VA
	Nesameletus	9	VA	-	-
	Zephlebia group	7	R	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	A	R
	Austroperla	9	R	-	-
	Megaleptoperla	9	R	R	-
	Zelandobius	5	R	-	R
	Zelandoperla	8	VA	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	XA	VA
	Hydraenidae	8	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	C	A
	Costachorema	7	R	A	C
	Hydrobiosis	5	R	C	A
	Beraeoptera	8	XA	R	-
	Confluens	5	R	-	-
	Helicopsyche	10	C	-	-
	Olinga	9	R	-	-
	Oxyethira	2	-	-	R
	Pycnocentrodes	5	XA	R	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	R	C
	Eriopterini	5	R	C	-
	Chironomus	1	-	-	C
	Maoridiamesa	3	R	A	VA
	Orthocladiinae	2	A	VA	A
	Tanypodinae	5	-	R	-
	Tanytarsini	3	R	R	C
	Empididae	3	-	R	R
	Ephydridae	4	-	-	C
	Muscidae	3	-	-	R
	Austrosimulium	3	R	R	C
	Tabanidae	3	-	R	-
		No of taxa	26	25	24
		MCI	127	102	86
		SQMCIs	7.1	6.4	4.5
		EPT (taxa)	17	11	9
		%EPT (taxa)	65	44	38
'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 24 February 2011

Taxa List	Site Code	MCI score	KPA000250	KPA000700	KPA000950
	Sample Number		**FWB11112**	**FWB11113**	**FWB11114**
NEMERTEA	Nemertea	3	-	R	-
ANNELIDA (WORMS)	Oligochaeta	1	-	R	VA
	Lumbricidae	5	-	-	R
MOLLUSCA	*Potamopyrgus*	4	R	C	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R	C
	Coloburiscus	7	A	VA	-
	Deleatidium	8	XA	XA	C
	Nesameletus	9	VA	R	R
	Rallidens	9	R	-	-
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	R	R	-
	Zelandoperla	8	C	R	-
COLEOPTERA (BEETLES)	Elmidae	6	XA	XA	VA
	Hydraenidae	8	R	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	XA	VA
	Costachorema	7	R	C	C
	Hydrobiosis	5	C	C	C
	Psilochorema	6	R	-	-
	Beraeoptera	8	A	R	-
	Olinga	9	C	-	-
	Oxyethira	2	-	R	-
	Pycnocentrodes	5	A	A	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A	C
	Eriopterini	5	C	R	-
	Maoridiamesa	3	C	R	-
	Orthocladiinae	2	C	VA	A
	Tanypodinae	5	R	-	-
	Tanytarsini	3	R	C	A
	Dolichopodidae	3	-	-	R
	Empididae	3	R	C	C
	Muscidae	3	-	C	R
	Austrosimulium	3	-	R	R
	Tanyderidae	4	-	R	-
		No of taxa	25	27	19
		MCI	122	103	95
		SQMCIs	7.0	5.8	4.1
		EPT (taxa)	14	11	7
		%EPT (taxa)	56	41	37
'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 12 October 2010

Taxa List	Site Code	MCI score	KRP000300	KRP000660
	Sample Number		FWB10290	FWB10293
ANNELIDA (WORMS)	Oligochaeta	1	C	C
MOLLUSCA	*Potamopyrgus*	4	A	VA
CRUSTACEA	Paraleptamphopidae	5	-	R
	Paranephrops	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	R	C
	Deleatidium	8	R	A
	Zephlebia group	7	R	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	-	A
COLEOPTERA (BEETLES)	Elmidae	6	C	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	A
	Costachorema	7	-	R
	Hydrobiosis	5	-	C
	Neurochorema	6	-	R
	Confluens	5	-	R
	Pycnocentrodes	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Maoridiamesa	3	-	R
	Orthocladiinae	2	C	A
	Polypedilum	3	R	-
	Tanytarsini	3	-	R
	Empididae	3	-	R
	Austrosimulium	3	R	R
	Tanyderidae	4	R	-
		No of taxa	13	22
		MCI	94	96
		SQMCIs	4.3	4.8
		EPT (taxa)	4	10
		%EPT (taxa)	31	45
'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 7 February 2011

Taxa List	Site Code	MCI score	KRP000300	KRP000660
	Sample Number		FWB11030	FWB11031
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R	-
NEMERTEA	Nemertea	3	R	R
ANNELIDA (WORMS)	Oligochaeta	1	A	A
	Lumbricidae	5	R	-
MOLLUSCA	*Ferrissia*	3	R	-
	Potamopyrgus	4	VA	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R
	Coloburiscus	7	-	R
	Deleatidium	8	R	A
	Zephlebia group	7	VA	A
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
	Ptilodactylidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A	VA
	Hydrobiosis	5	C	A
	Neurochorema	6	-	R
	Oxyethira	2	-	A
	Pycnocentrodes	5	-	C
	Triplectides	5	R	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A
	Eriopterini	5	R	-
	Hexatomini	5	R	-
	Limonia	6	R	-
	Orthocladiinae	2	C	A
	Polypedilum	3	-	R
	Tanypodinae	5	R	-
	Tanytarsini	3	-	A
	Empididae	3	R	C
	Muscidae	3	-	R
	Psychodidae	1	-	R
	Austrosimulium	3	A	A
	Tanyderidae	4	R	R
ACARINA (MITES)	Acarina	5	-	R
		No of taxa	24	25
		MCI	95	87
		SQMCIs	5.2	4.1
		EPT (taxa)	6	9
		%EPT (taxa)	25	36
'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 Waiongana Stream: spring SEM survey sampled on 3 November 2010

Taxa List	Site Code	MCI score	WKR000500	WKR000700
	Sample Number		FWB10343	FWB10344
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	A	A
MOLLUSCA	*Potamopyrgus*	4	C	A
CRUSTACEA	*Paracalliope*	5	-	C
	Paraleptamphopidae	5	C	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	VA
	Coloburiscus	7	A	A
	Zephlebia group	7	VA	A
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	A	A
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	VA
	Costachorema	7	C	R
	Ecnomidae/Psychomyiidae	6	-	C
	Hydrobiosis	5	C	C
	Orthopsyche	9	R	-
	Psilochorema	6	-	R
	Olinga	9	R	-
	Pycnocentria	7	-	C
	Pycnocentrodes	5	C	R
	Triplectides	5	-	R
	Zelolessica	7	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	R
	Maoridiamesa	3	VA	R
	Orthocladiinae	2	VA	C
	Polypedilum	3	R	R
	Tanytarsini	3	C	C
	Empididae	3	R	-
		No of taxa	23	23
		MCI	102	100
		SQMCIs	4.8	5.5
		EPT (taxa)	11	12
		%EPT (taxa)	48	52
'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 15 February 2011

Taxa List	Site Code	MCI score	WKR000500	WKR000700
	Sample Number		FWB11095	FWB11097
NEMERTEA	Nemertea	3	-	R
NEMATODA	Nematoda	3	R	R
ANNELIDA (WORMS)	Oligochaeta	1	C	A
MOLLUSCA	*Potamopyrgus*	4	C	A
CRUSTACEA	*Paracalliope*	5	-	C
	Paraleptamphopidae	5	-	C
	Paranephrops	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	XA	XA
	Coloburiscus	7	R	VA
	Deleatidium	8	A	R
	Zephlebia group	7	R	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	-
COLEOPTERA (BEETLES)	Elmidae	6	XA	XA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	XA	VA
	Costachorema	7	R	-
	Hydrobiosis	5	C	C
	Psilochorema	6	R	R
	Oecetis	4	-	R
	Pycnocentria	7	-	R
	Pycnocentrodes	5	C	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	R
	Eriopterini	5	R	-
	Orthocladiinae	2	C	-
	Polypedilum	3	R	-
	Tanytarsini	3	C	C
	Tanyderidae	4	-	R
		No of taxa	20	22
		MCI	100	101
		SQMCIs	5.7	6.2
		EPT (taxa)	10	10
		%EPT (taxa)	50	45
'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 17 November 2010

Taxa List	Site Code	MCI score	TNH000090	TNH000200	TNH000515
	Sample Number		FWB10420	FWB10421	FWB10422
NEMERTEA	Nemertea	3	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	A	R	A
	Lumbricidae	5	R	-	-
MOLLUSCA	*Latia*	5	-	R	R
	Potamopyrgus	4	A	-	-
CRUSTACEA	*Paracalliope*	5	-	-	R
	Paranephrops	5	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	VA	R
	Coloburiscus	7	-	C	R
	Deleatidium	8	XA	VA	C
	Rallidens	9	R	-	-
	Zephlebia group	7	C	C	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	A	-
	Zelandobius	5	R	A	C
	Zelandoperla	8	-	R	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	A
	Dytiscidae	5	-	R	-
	Hydrophilidae	5	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	C	VA
	Costachorema	7	R	R	R
	Hydrobiosis	5	A	R	C
	Oxyethira	2	C	-	-
	Pycnocentrodes	5	-	C	C
	Triplectides	5	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	C	A
	Eriopterini	5	R	-	-
	Maoridiamesa	3	-	-	A
	Orthocladiinae	2	A	C	VA
	Polypedilum	3	R	-	C
	Tanytarsini	3	-	R	R
	Empididae	3	-	R	-
	Austrosimulium	3	XA	C	C
	Tabanidae	3	R	-	-
	Tanyderidae	4	R	R	-
		No of taxa	25	22	20
		MCI	96	102	98
		SQMCIs	5.4	6.5	3.4
		EPT (taxa)	10	11	9
		%EPT (taxa)	40	50	45
'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 16 March 2011

Taxa List	Site Code	MCI score	TNH000090	TNH000200	TNH000515
	Sample Number		FWB11140	FWB11141	FWB11142
NEMERTEA	Nemertea	3	C	C	A
NEMATODA	Nematoda	3	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	A	C	VA
	Lumbricidae	5	-	-	R
MOLLUSCA	*Latia*	5	-	-	A
	Potamopyrgus	4	VA	VA	VA
CRUSTACEA	Talitridae	5	-	-	C
	Paratya	3	R	-	-
	Paranephrops	5	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	VA	C
	Coloburiscus	7	C	VA	-
	Deleatidium	8	VA	A	-
	Mauiulus	5	-	-	R
	Zephlebia group	7	VA	VA	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-	-
	Megaleptoperla	9	C	-	-
	Zelandobius	5	-	C	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	XA	XA
	Hydraenidae	8	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	A	XA
	Hydrobiosis	5	C	A	C
	Orthopsyche	9	-	R	-
	Psilochorema	6	R	R	-
	Oxyethira	2	R	R	-
	Pycnocentria	7	-	R	-
	Pycnocentrodes	5	-	R	C
	Triplectides	5	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C	R
	Eriopterini	5	C	R	-
	Chironomus	1	R	-	-
	Harrisius	6	C	R	-
	Orthocladiinae	2	R	R	A
	Polypedilum	3	R	-	R
	Tanytarsini	3	C	C	C
	Paradixa	4	R	-	-
	Empididae	3	-	R	-
	Austrosimulium	3	VA	C	C
	Tanyderidae	4	R	C	-
		No of taxa	28	26	21
		MCI	95	98	87
		SQMCIs	5.4	6.0	4.5
		EPT (taxa)	10	11	6
		%EPT (taxa)	36	42	29
'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 12 October 2010

Taxa List	Site Code	MCI score	HRK000085
	Sample Number		FWB10296
ANNELIDA (WORMS)	Oligochaeta	1	A
	Lumbricidae	5	R
MOLLUSCA	*Potamopyrgus*	4	VA
CRUSTACEA	*Paracalliope*	5	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C
	Coloburiscus	7	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R
	Zelandobius	5	R
COLEOPTERA (BEETLES)	Elmidae	6	R
	Ptilodactylidae	8	R
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R
	Orthopsyche	9	R
	Oxyethira	2	R
	Triplectides	5	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C
	Eriopterini	5	R
	Orthocladiinae	2	A
	Empididae	3	R
	Austrosimulium	3	C
ACARINA (MITES)	Acarina	5	R
		No of taxa	20
		MCI	97
		SQMCIs	3.8
		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 175 Macroinvertebrate fauna of the Herekawe Stream: summer SEM survey sampled on 1 March 2011

Taxa List	Site Code	MCI score	HRK000085
	Sample Number		FWB11125
NEMATODA	Nematoda	3	R
ANNELIDA (WORMS)	Oligochaeta	1	A
MOLLUSCA	*Potamopyrgus*	4	VA
CRUSTACEA	*Paracalliope*	5	XA
	Paranephrops	5	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R
	Coloburiscus	7	C
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R
	Orthopsyche	9	R
	Polyplectropus	6	R
	Oxyethira	2	R
	Triplectides	5	A
DIPTERA (TRUE FLIES)	*Harrisius*	6	R
	Orthocladiinae	2	R
	Tanypodinae	5	R
	Austrosimulium	3	C
ACARINA (MITES)	Acarina	5	R
		No of taxa	17
		MCI	94
		SQMCIs	4.7
		EPT (taxa)	6
		%EPT (taxa)	35
'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, 2010-2011 and historical MCI scores, predicted scores and 1995-2011 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 2011

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI Values: SEM 1995 to 2011: Spring 2010	Summer 2011	1995-2011: Range	Medians: Spring	Summer	Overall	Median stream 'health' category: Generic[3]	Predicted by reach[4]	Predicted: Altitude[1]	Distance[1]	REC[2]	Trends (1995-2010): p	p>FDR	+ / -	Ecological significance
STY000300	CX/H/VA/S/MO/MG	160	7.3	(125)	(115)	64-160	113	113	113	Good	Better than	101[+]	109[0]	128[-]	0.159	0.266	-ve	-
STY000400	CX/H/VA/S/MO/MG	70	12.5	(127)	(95)	0-160	109	109	108	Good	Well above	92[+]	103[0]	115[0]	0.289	0.395	-ve	-
TMR000150	CX/H/VA/IF/LO/HG	420	0	125	143	119-144	135	137	135	Very good	Better than	127[0]	132[0]	141[0]	0.482	0.546	-ve	-
TMR000375	CX/L/VA/P/MO/MG	100	10.9	115	112	89-120	101	103	102	Good	Expected	95[0]	105[0]	117[-]	<0.0001	<0.001	+ve	Yes
MRK000420	WW/L/VA/P/MO/LG	60	N/A	103	90	75-105	91	89	89	Fair	Expected	91[0]	N/A	92[0]	<0.0001	<0.001	+ve	Yes
WGA000260	CX/L/VA/P/MO/LG	140	16.1	95	98	82-112	97	94	95	Fair	Expected	99[0]	100[0]	99[0]	0.224	0.328	+ve	-
WGA000450	WW/L/VA/P/MO/LG	20	31.2	95	90	72-102	94	83	85	Fair	Expected	86[0]	93[0]	88[0]	<0.0002	0.001	+ve	Yes
WKH000100	CX/H/VA/IF/LO/HG	460	0	140	126	121-146	133	124	127	Very good	Expected	131[0]	132[0]	137[0]	0.939	0.939	+ve	-
WKH000500	CX/H/VA/P/MO/MG	175	10.6	119	117	87-122	110	103	109	Good	Better than	102[0]	105[0]	115[0]	0.028	0.081	+ve	Yes
WKH000920	CX/H/VA/P/HO/LG	20	26.6	110	88	71-110	101	91	94	Fair	Better than	86[0]	95[0]	97[0]	0.246	0.346	+ve	-
WKH000950	CX/H/VA/P/HO/LG	2	28.4	105	84	70-111	92	82	88	Fair	Expected	85[0]	94[0]	97[0]	0.218	0.328	+ve	-
MGE000970	CX/L/VA/P/MO/LG	90	15.6	104	96	86-113	106	99	104	Good	Better than	94[0]	101(0)	101[0]	0.444	0.536	-ve	-
MGN000195	CX/H/VA/P/MO/LG	330	8.7	131	121	113-143	130	123	126	Very good	Well above	118[0]	107[+19]	124[0]	0.101	0.176	-ve	-
MGN000427	CX/L/VA/P/HO/MG	140	37.9	109	97	77-115	102	95	98	Fair	Better than	99[0]	91[0]	103[0]	0.869	0.886	-ve	-
MKW000200	CX/H/VA/IF/MO/MG	380	2.3	129	117	100-141	129	123	128	Very good	Expected	123[0]	121[0]	130[0]	0.095	0.173	-ve	-
MKW000300	CX/H/VA/P/MO/LG	150	15.5	115	107	90-115	106	98	101	Good	Better than	100[0]	101[0]	111[0]	0.776	0.817	-ve	-
WTR000850	WX/L/SS/P/HO/LG	15	N/A	91	77	64-101	90	78	86	Fair	Expected	85[0]	N/A	98[-]	0.045	0.102	+ve	-
MGT000488	WN/L/VA/P/LO/LG	30	N/A	69	79	56-85	77	78	77	N/A	N/A[s]	N/A	N/A	80[0]	0.454	0.536	-ve	-
MGT000520	WW/L/VA/U/LO/LG	20	N/A	52	70	44-76	63	64	63	N/A	N/A[s]	N/A	N/A	88[-]	0.004	0.020	+ve	Yes
WMK000100	WW/L/VA/P/LO/HG	160	0	139	130	121-139	133	130	131	Very good	Expected	101[+]	132[0]	128[0]	0.701	0.759	+ve	-
WMK000298	WW/L/VA/P/MO/MG	1	4.0	101	86	75-101	91	88	89	Fair	Expected	85[0]	116[-]	103[-]	0.051	0.111	+ve	-
WAI000110	WW/L/VA/P/MO/LG	50	N/A	93	99	80-99	91	88	89	Fair	N/A	N/A	N/A	91[0]	0.020	0.066	+ve	Yes
PNH000200	CX/H/YA/IF/MO/MG	270	4.4	127	120	104-133	126	118	122	Very good	Well above	112[0]	115[0]	121[0]	0.088	0.170	+ve	-
PNH000900	CW/L/VA/P/MO/LG	20	20.9	90	93	70-105	91	82	86	Fair	Expected	86[0]	98[-]	100[-]	0.004	0.020	+ve	Yes
PAT000200	CX/H/VA/IF/MO/MG	500	1.9	138	138	127-145	139	137	138	Very good	Better than	135[0]	125[+]	129[0]	0.483	0.546	+ve	-
PAT000315	CX/H/VA/P/MO/LG	300	12.9	119	118	99-130	115	108	110	Good	Better than	115[0]	103[0]	112[0]	0.216	0.328	+ve	-
PAT000360	CW/L/VA/P/HO/LG	240	19.2	105	97	86-105	99	97	97	Fair	Expected	109[-]	99[0]	109[-]	0.366	0.476	+ve	-
MGH000950	CW/L/SS/P/HO/LG	120	N/A	93	95	77-104	90	86	88	Fair	N/A	N/A	N/A	117[-]	<0.0001	0.0001	+ve	Yes
WGG000115	CX/H/VA/IF/LO/MG	540	0.7	131	128	122-139	132	134	133	Very good	Expected	140[0]	130[0]	131[0]	0.096	0.172	+ve	-
WGG000150	CX/H/VA/P/LO/MG	380	7.2	133	130	119-139	132	128	129	Very good	Well above	123[0]	110[+]	124[0]	0.786	0.817	-ve	-
WGG000500	CW/L/VA/P/MO/LG	200	23.0	103	100	91-115	102	100	101	Good	Better than	105[0]	97[0]	110[0]	0.010	0.034	+ve	No
WGG000665	CW/L/VA/P/HO/MG	180	29.6	104	98	77-105	97	93	94	Fair	Expected	103[0]	94[0]	102[0]	0.085	0.170	+ve	-
WGG000895	CW/L/VA/P/HO/LG	40	63.0	93	97	73-105	95	92	95	Fair	Better than	89[0]	85[0]	92[0]	0.205	0.328	+ve	-
WGG000995	CW/L/VA/P/HO/MG	5	66.6	92	84	69-98	92	84	88	Fair	Expected	85[0]	85[0]	95[0]	0.087	0.170	+ve	-
MWH000380	WW/L/M/P/MO/LG	200	N/A	76	77	58-85	75	72	74	N/A	N/A[s]	N/A	N/A	92[-]	0.028	0.081	+ve	No
MWH000490	CN/L/VA/P/MO/LG	190	N/A	90	84	63-90	79	75	77	Poor	Worse than	104[-]	N/A	93[-]	0.036	0.088	+ve	Yes
HTK000350	WX/L/VA/P/MO/LG	60	N/A	104	101	79-105	96	91	94	Fair	Expected	91[0]	N/A	95[0]	<0.0004	0.002	+ve	Yes
HTK000425	WW/L/VA/P/MO/LG	30	N/A	109	103	91-115	104	100	102	Good	Better than	87[+]	N/A	92[0]	0.006	0.024	+ve	No
HTK000745	WW/L/VA/U/MO/MG	5	N/A	101	69	69-101	85	86	86	Fair	Expected	85[0]	N/A	93[0]	0.648	0.717	+ve	-
KPK000250	CX/H/VA/IF/MO/MG	380	3.3	131	133	125-138	130	128	129	Very good	Well above	123[0]	118[+]	137[0]	0.409	0.507	+ve	-
KPK000500	CX/H/VA/P/MO/MG	260	9.2	133	116	98-133	120	113	116	Good	Better than	111[0]	107[0]	127[-]	0.001	0.006	+ve	Yes
KPK000660	CX/H/VA/P/MO/LG	170	15.5	107	110	71-122	102	101	101	Good	Better than	102[0]	101[0]	122[-]	<0.0001	<0.0001	+ve	Yes
KPK000880	CW/H/VA/P/MO/LG	60	25.7	108	104	66-108	91	87	91	Fair	Better than	91[0]	95[0]	106[-]	0.034	0.088	+ve	Yes
KPK000990	CW/L/VA/P/HO/LG	5	31.1	94	93	69-98	92	87	91	Fair	Better than	85[0]	93[0]	96[0]	0.039	0.094	+ve	Yes
KTK000150	CW/L/VA/P/HO/LG	420	0	135	133	112-148	138	136	137	Very good	Better than	127[0]	132[0]	131[0]	0.376	0.476	-ve	-
KTK000248	WX/L/VA/P/MO/LG	5	18.1	102	101	81-116	102	103	102	Good	Better than	85[+]	99[0]	96[0]	0.034	0.088	+ve	Yes
KPA000250	CX/H/VA/P/MO/MG	240	5.7	127	122	83-129	109	109	108	Good	Better than	109[0]	112[0]	111[0]	<0.001	0.001	+ve	Yes
KPA000700	CX/H/VA/P/MO/MG	140	13.5	102	103	78-108	93	92	93	Fair	Expected	99[0]	103[0]	105[-]	0.005	0.022	+ve	Yes
KPA000950	CX/L/VA/P/MO/LG	20	25.2	86	95	76-98	89	81	85	Fair	Expected	86[0]	96[-]	99[-]	0.227	0.328	+ve	-
KRP000300	WX/L/VA/P/LO/LG	180	N/A	94	95	80-103	93	95	93	Fair	Expected	103[0]	N/A	92[0]	<0.0001	0.0001	+ve	Yes
KRP000660	WW/L/VA/P/LO/LG	120	N/A	96	87	70-103	93	89	91	Fair	Expected	97[0]	N/A	102[-]	0.005	0.022	+ve	Yes
WKR000500	WW/L/VA/P/MO/LG	150	N/A	102	100	88-104	99	96	95	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	100	101	92-103	99	98	99	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	96	95	92-106	98	96	97	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	102	98	92-108	105	102	105	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	98	87	84-104	97	86	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	97	94	68-97	89	81	87	Fair	N/A	N/A	N/A	89[0]	0.313	0.417	+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 sties; N/A[s] = soft-bedded sites