# Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2014-2015

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# Executive summary

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

This report covers the 2014-2015 monitoring year. Biological surveys were performed in spring (October 2014 mainly through to November 2014 with some wet weather delay extending through to early January, 2015) and summer (February to March 2015), during a prolonged late summer very low flow period. Each seasonal 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 with more recent wastes diversions out of the river, and the Waiongana Stream as a stream from which there is a major water abstraction (although not currently exercised). The Timaru, Mangaoraka, Waiokura (added in 2007) and Punehu Streams were included as streams within primary agricultural catchments. The Kaupokonui River, Mangorei Stream and Waimoku Stream were selected to monitor the progress of riparian planting in these catchments. These catchments had been targeted in management policies for riparian planting initiatives. The Katikara and Kapoaiaia streams are western Taranaki streams also targeted for riparian planting initiatives, which have been part of the monitoring programme since 2000. The Tangahoe River was included in 2007 to monitor land use changes in an eastern hill country catchment. The Kurapete Stream was added to the programme as an example of a small seepage ringplain stream where significant improvements to a major point source discharge have been implemented. The Waiau Stream is an example of a northern lowland catchment. The Mangawhero and Mangati Streams were selected as examples of small, degraded streams. The Huatoki Stream was selected as an example of a stream influenced by urbanisation and also in part by riparian vegetation while the Herekawe Stream, on the western outskirts of the New Plymouth urban area (with a lengthy consent monitoring record), has been added in order to monitor the impact of relatively recent community walkway planting initiatives.

For sites located lower in catchments the proportion of 'sensitive' taxa in the macroinvertebrate communities generally have been lower in summer than in spring, coincident with lower flows and increased smothering of habitats by more widespread algal growth within rivers and streams in summer. The proportion of 'sensitive' taxa in the macroinvertebrate communities has decreased 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. Generally, sites in 2014-2015 exhibited the typical summer trend of decreased median scores although only on average by four units, and more particularly at lower reach sites (six units). Long term data have indicated lower median spring and summer scores by three and five units respectively.

During the 2014-2015 period, spring scores were insignificantly higher than both summer and historical median scores.

Few sites (one in mid-reaches and two in lower reaches) recorded new historical maximum MCI scores, while one decrease in historical minimum score was recorded (in the lower reaches of the Huatoki Stream) in the 2014-2015 period. Small increases in overall (twenty-year) median scores resulted at seven sites (mainly in mid and lower reaches) while very small decreases were recorded at one upper and one lower reach sites.

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) predictions.

The trends through time have been evaluated and will continue to be assessed on an annual basis as the SEM programme continues. Only seven sites have shown any indications of temporal deterioration over the twenty-year period (several as a result of headwater erosion effects) but no statistically significant strong temporal deterioration in MCI scores has been found at any site. Twenty-two sites have shown very strong improvements and a further seven sites, strong improvement, all but four of which were of ecological importance. Several of these trends appear to have plateaued more recently. Proportionately fewer of these sites were located in the lower reaches of ringplain catchments where the macroinvertebrate communities tend to be 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 on occasions in past years. Most of these sites continued to show recovery from these impacts over the 2014–2015 period.

The recommendations for the 2015-2016 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, with the proposed addition of two large hill-country catchment, lower reach sites, consistent with the same additional sites established for the state of the environment physicochemical programme.

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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 an interpretation of these results, together with an update of trends in the data.

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

This report summarises the results for the sites surveyed in the freshwater biological SEM programme over the 2014-2015 monitoring year, the twentieth year of this programme.

# 2. Monitoring activity

## 2.1 Introduction

The Council commenced the freshwater biological SEM programme in spring 1995. The 2013-2014 monitoring year was therefore the nineteenth year in which this SEM programme was undertaken. This report presents the results from the sites surveyed in the 2013-2014 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 are normally performed twice during the monitoring year, once during spring (October to December) and once during summer (February and March). Sampling dates for each site are detailed in Table 3.

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). Macroinvertebrate taxa 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. 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 (Stark and Fowles, 2009).

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 accuracy of determination of river length measurements].

### 2.3.3 Gradations of biological 'health'

A refinement of Stark's classification (Stark, 1985, Boothroyd and Stark, 2000; and Stark and Maxted, 2007) has been made in order to grade the biological 'health' based upon MCI 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 more resolution of stream 'health' in the context of more precise upper and lower MCI score bands, than the earlier grading classification (Stark and Fowles, 2015). Despite the acknowledgement that the boundaries between gradings may be fuzzy (Stark and Maxted, 2007) these gradings can assist with the assessment of trends in long term temporal data.

Following the establishment of relationships between MCI scores and ringplain stream altitude and distance from source (Stark and Fowles, 2009), biological 'health' may also be graded against predictive values recognising the degree of degradation between the National Park and the coast. These 'predictive' gradings (Table 2) may be applied throughout the length of ringplain streams and range from 'better than expected' through 'expected' to 'worse than expected' depending on the deviation of the MCI value from the predicted value.

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

| Grading | Differences in MCI scores from predicted values |
|---|---|
| Better than expected | plus more than 10 units |
| Expected | +/- 0 to 10 units |
| Worse than expected | minus more than 10 units |

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 twenty year period (1995-2015) under standard TRC programme protocols, have been statistically analysed for trends using documented methodology (Stark and Fowles, 2006) where sites have had a minimum of 10 years continuous data recorded. 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 importance. However, a trend may be statistically significant but have no ecological importance or vice versa. The consideration of ecological importance 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 importance.

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

## 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 2014-2015 period involved the continuation of a riparian vegetation monitoring component incorporating five sites in the Kaupokonui River (see Table 3) and five sites in western Taranaki ring plain streams (Katikara Stream and Kapoaiaia Stream). Evaluations of the effects of, and recovery from, extensive erosion in the headwaters of the Waiaua River had been included in this programme. These surveys commenced in December 1998 and the two sites on the Waiaua River were incorporated into the SEM biological monitoring programmes since the initial documentation of the effects and recovery was established. This river continued to be affected by headwater erosion in more recent years. Therefore, the programme was reviewed in 2006 and the Waiaua River excluded from the SEM programme. The Kurapete Stream (upstream and 5.5km downstream of the Inglewood oxidation pond system) has been monitored throughout the SEM period, using the appropriate SEM protocols, and has been included in the programme. Two additional sites in the Waiwhakaiho River catchment were included in 2002-2003 in recognition of the importance of this major catchment.

**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 | 7 Jan 15 | 24 Mar 15 |
| | Hangatahua (Stony) R | SH45 | STY000400 | 1674632 | 5661558 | 12.5 | 70 | 7 Jan 15 | 24 Mar 15 |
| | Maketawa S | Opp Derby Road | MKW000200 | 1702192 | 5656304 | 2.3 | 380 | 8 Dec 14 | 20 Feb 15 |
| | Maketawa S | Tarata Road | MKW000300 | 1708784 | 5665231 | 15.5 | 150 | 8 Dec 14 | 20 Feb 15 |
| Large catchment/ multiple impacts | Waiwhakaiho R | National Park | WKH000100 | 1696096 | 5658351 | 0 | 460 | 16 Oct 14 | 13 Feb 15 |
| | Waiwhakaiho R | SH3 (Egmont Village) | WKH000500 | 1698297 | 5666893 | 10.6 | 175 | 16 Oct 14 | 13 Feb 15 |
| | Waiwhakaiho R | Constance St (NP) | WKH000920 | 1695827 | 2677271 | 26.6 | 20 | 16 Oct 14 | 13 Feb 15 |
| | Waiwhakaiho R | Adjacent to L Rotomanu | WKH000950 | 1696587 | 2678336 | 28.4 | 2 | 16 Oct 14 | 13 Feb 15 |
| | Mangorei S | SH3 | MGE000970 | 1696094 | 5671500 | 21.6 | 90 | 16 Oct 14 | 13 Feb 15 |
| | Manganui R | SH3 | MGN000195 | 1708871 | 5651282 | 8.7 | 330 | 8 Dec 14 | 20 Feb 15 |
| | Manganui R | Bristol Road | MGN000427 | 1711210 | 5667887 | 37.9 | 140 | 8 Dec 14 | 20 Feb 15 |
| | Waitara R | Mamaku Road | WTR000850 | 1708384 | 5678739 | N/A | 15 | 2 Dec 14 | 20 Feb 15 |
| | Patea R | Barclay Rd | PAT000200 | 1702620 | 5646598 | 1.9 | 500 | 25 Nov 14 | 10 Feb 15 |
| | Patea R | Swansea Rd | PAT000315 | 17118011 | 5644382 | 12.9 | 300 | 25 Nov 14 | 10 Feb 15 |
| | Patea R | Skinner Rd | PAT000360 | 1715919 | 5644681 | 19.2 | 240 | 25 Nov 14 | 10 Feb 15 |
| Intensive usage | Waingongoro R | 700m d/s Nat Park | WGG000115 | 1700835 | 5645086 | 0.7 | 540 | 15 Oct 14 | 12 Feb 15 |
| | Waingongoro R | Opunake Rd | WGG000150 | 1705692 | 5642523 | 7.2 | 380 | 15 Oct 14 | 12 Feb 15 |
| | Waingongoro R | Eltham Rd | WGG000500 | 1710576 | 5634824 | 23.0 | 200 | 15 Oct 14 | 12 Feb 15 |
| | Waingongoro R | Stuart Rd | WGG000665 | 1709784 | 5632049 | 29.6 | 180 | 15 Oct 14 | 12 Feb 15 |
| | Waingongoro R | SH45 | WGG000895 | 1704042 | 5618667 | 63.0 | 40 | 15 Oct 14 | 12 Feb 15 |
| | Waingongoro R | Ohawe Beach | WGG000995 | 1702531 | 5617624 | 66.6 | 10 | 15 Oct 14 | 12 Feb 15 |
| Primary agricultural | Timaru S | Carrington Road | TMR000150 | 1684423 | 5659634 | 0 | 420 | 7 Jan 15 | 24 Mar 15 |
| | Timaru S | SH45 | TMR000375 | 1679509 | 5665554 | 10.9 | 100 | 7 Jan 15 | 24 Mar 15 |
| | Mangaoraka S | Corbett Road | MRK000420 | 1702538 | 5676320 | N/A | 60 | 23 Oct 14 | 11 Feb 15 |
| | Punehu S | Wiremu Rd | PNH000200 | 1687323 | 5637020 | 4.4 | 270 | 13 Oct 14 | 4 Feb 15 |
| | Punehu S | SH45 | PNH000900 | 1677946 | 5627786 | 20.9 | 20 | 13 Oct 14 | 4 Feb 15 |
| | Waiokura S | Skeet Rd | WKR000500 | 1698807 | 5628892 | N/A | 150 | 14 Oct 14 | 19 Feb 15 |
| | Waiokura S | Manaia Golf Course | WKR000700 | 1697636 | 5622019 | N/A | 70 | 14 Oct 14 | 19 Feb 15 |
| Eastern hill country | Tangahoe R | Upper Valley | TNH000090 | 1725340 | 5626101 | N/A | 85 | 20 Nov 14 | 18 Feb 15 |
| | Tangahoe R | Tangahoe Vly Rd bridge | TNH000200 | 1719126 | 5622681 | N/A | 65 | 20 Nov 14 | 18 Feb 15 |
| | Tangahoe R | d/s railbridge | TNH000515 | 1715751 | 5612470 | N/A | 15 | 20 Nov 14 | 18 Feb 15 |
| | Mangaehu R | Raupuha Rd | MGH000950 | 1726300 | 5639062 | N/A | 120 | 25 Nov 14 | 10 Feb 15 |
| Riparian | Waimoku S | Lucy's Gully | WMK000100 | 1681324 | 5666240 | 0 | 160 | 7 Jan 15 | 24 Mar 15 |
| | Waimoku S | Beach | WMK000298 | 1681725 | 5669851 | 4.0 | 1 | 7 Jan 15 | 24 Mar 15 |
| Western | Katikara S | Carrington Road | KTK000150 | 1683566 | 5657855 | 0 | 420 | 16 Oct 14 | 17 Feb 15 |
| | Katikara S | Beach | KTK000248 | 1676597 | 5667473 | 18.1 | 5 | 16 Oct 14 | 17 Feb 15 |
| | Kapoaiaia S | Wiremu Road | KPA000250 | 1678009 | 5652025 | 5.7 | 240 | 1 Oct 14 | 17 Feb 15 |
| | Kapoaiaia S | Wataroa Road | KPA000700 | 1672739 | 5652272 | 13.5 | 140 | 1 Oct 14 | 17 Feb 15 |
| | Kapoaiaia S | Cape Egmont | KPA000950 | 1665690 | 5652452 | 25.2 | 20 | 1 Oct 14 | 17 Feb 15 |
| Southern | Kaupokonui R | Opunake Road | KPK000250 | 1698088 | 5639231 | 3.3 | 380 | 14 Oct 14 | 19 Feb 15 |
| | Kaupokonui R | U/s Kaponga oxi ponds | KPK000500 | 1698609 | 5634423 | 9.2 | 260 | 14 Oct 14 | 19 Feb 15 |
| | Kaupokonui R | U/s Lactose Co. | KPK000660 | 1697613 | 5629791 | 15.5 | 170 | 14 Oct 14 | 19 Feb 15 |
| | Kaupokonui R | Upper Glenn Road | KPK000880 | 1693026 | 5622705 | 25.7 | 60 | 14 Oct 14 | 19 Feb 15 |
| | Kaupokonui R | Near mouth | KPK000990 | 1691209 | 5620444 | 31.1 | 5 | 14 Oct 14 | 19 Feb 15 |
| Small degraded ('poor') catchment | Mangati S | D/s railway line | MGT000488 | 1700095 | 5678043 | N/A | 30 | 2 Dec 14 | 12 Feb 15 |
| | Mangati S | Te Rima Pl, Bell Block | MGT000520 | 1699385 | 5679103 | N/A | 20 | 2 Dec 14 | 12 Feb 15 |
| | Mangawhero S | u/s Eltham WWT Plant | MWH000380 | 1712475 | 5633431 | N/A | 200 | 14 Oct 14 | 12 Feb 15 |
| | Mangawhero S | d/s Mangawharawhara S | MWH000490 | 1710795 | 5632738 | N/A | 190 | 14 Oct 14 | 12 Feb 15 |
| | Kurapete S | u/s Inglewood WWT Plant | KRP000300 | 1705087 | 5665510 | N/A | 180 | 23 Oct 14 | 11 Feb 15 |
| | Kurapete S | 6 km d/s Inglewood WWTP | KRP000660 | 1709239 | 5667481 | N/A | 120 | 23 Oct 14 | 11 Feb 15 |
| Urbanisation | Huatoki S | Hadley Drive | HTK000350 | 1693349 | 5671486 | N/A | 60 | 16 Oct 14 | 31 Jan 15 |
| | Huatoki S | Huatoki Domain | HTK000425 | 1693041 | 5673404 | N/A | 30 | 16 Oct 14 | 31 Jan 15 |
| | Huatoki S | Molesworth St | HTK000745 | 1692800 | 5676424 | N/A | 5 | 16 Oct 14 | 31 Jan 15 |
| | | | | | | | | 16 Oct 14 | 31 Jan 15 |
| | Herekawe S | Centennial Drive | HRK000085 | 1688283 | 5674972 | N/A | 5 | 16 Oct 14 | 20 Feb 15 |
| Northern lowland catchment | Waiau S | Inland North Road | WAI000110 | 1714587 | 5680018 | N/A | 50 | 23 Oct 14 | 11 Feb 15 |
| Major abstraction | Waiongana S | SH3a | WGA000260 | 1705159 | 5669554 | 16.1 | 140 | 8 Dec 14 | 20 Feb 15 |
| | Waiongana S | Devon Road | WGA000450 | 1704063 | 5680381 | 31.2 | 20 | 8 Dec 14 | 20 Feb 15 |

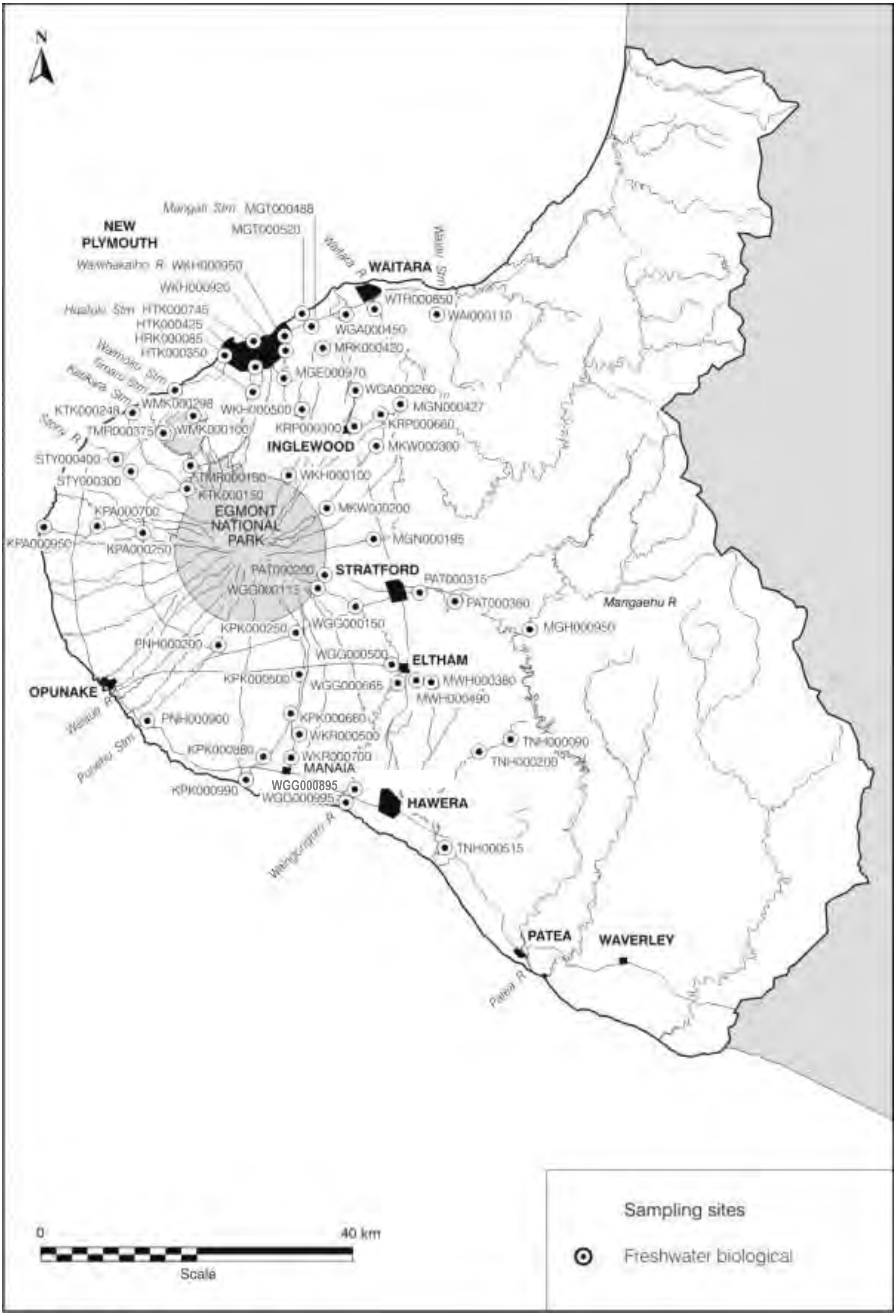



**Figure 1** Location of macroinvertebrate fauna sampling sites for the 2014-2015 SEM programme

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. Occasional headwater erosion events have been documented in the upper river with an instance of severe (orange) discolouration in spring 2014 due to release of iron oxide from a small headwater tributary.

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

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

The Waitara River flows south-west and then north-west out of the eastern hill country through a mix of agricultural land and native forest before passing through the town of Waitara and out to sea. It has a different character from the steep ring plain rivers and carries a high silt load. The 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, and is a small catchment to the north of the Waitara River. It flows for 12.5 km to the sea. The stream was included in the SEM programme in the 1999-2000 monitoring year as an example of a northern lowland catchment. The sampling site at Inland North Road is located in a pasture setting.

The Punehu Stream is representative of a south-western Taranaki catchment subject primarily to intensive agricultural land use with water quality affected by diffuse source run-off and point source discharges from dairy shed treatment pond effluents particularly in the Mangatawa Stream, a small lower reach tributary. No industrial discharges to the stream system are known to occur. Both sites were Taranaki ring plain survey sites (TCC, 1984) and the lower site near the coast remains a NIWA hydrological recording station as a representative basin. The upstream site is representative of relatively unimpacted stream water quality although it lies approximately 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 treated wastewater subsequently has continued to be irrigated onto farmland in this manner. The Eltham municipal wastes were permanently diverted by pipeline to Hawera in June 2010. The Stuart Road site, a further six km downstream is located below these 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 1997-1998 monitoring year. The stream rises one kilometre outside the National Park boundary on the foothills of the Pouakai Range. It flows through agricultural land for 12.5 km to the outskirts of New Plymouth where it enters native forest reserve. The stream flows for four and a half kilometres alongside walkways and beneath the central business district of New Plymouth before entering the sea next to Puke Ariki Landing. Within New Plymouth it flows through a culvert in a flood retention dam and over a small weir in the Huatoki Reserve prior to the business section of the city. Beautification works adjacent to 'Centre City' near the stream mouth (in 2010) involved the creation of a weir and fishpass immediately upstream of the lowest site which subsequently has altered the flow regime at this site and created a run-like habitat with intermittent flow variability rather than the previous riffle habitat.

The Herekawe Stream is a small seepage stream on the western boundary of New Plymouth. It drains a mainly urban catchment and receives stormwater discharges particularly in its lower reaches. 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 hydrological 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 2014-2015 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 | 6 | 17 | 11 | 12 |
| Hangatahua (Stony) R | SH45 | 6 | 17 | 11 | 12 |
| Timaru S | Carrington Road | (6) | (17) | (11) | (12) |
| Timaru S | SH45 | (6) | (17) | (11) | (12) |
| Mangaoraka S | Corbett Road | 25 | 81 | 9 | 63 |
| Waiongana S | SH3a | 12 | 23 | 17 | 18 |
| Waiongana S | Devon Road | 12 | 23 | 17 | 18 |
| Waiwhakaiho R | National Park | 7 | 10 | 7 | 11 |
| Waiwhakaiho R | SH3 (Egmont Village) | 7 | 10 | 7 | 11 |
| Waiwhakaiho R | Constance St (NP) | 7 | 10 | 7 | 11 |
| Waiwhakaiho R | Adjacent Lake Rotomanu | 7 | 10 | 7 | 11 |
| Mangorei S | SH3 | (7) | (10) | (7) | (11) |
| Manganui R | SH3 | 20 | 20 | 18 | 19 |
| Manganui R | Bristol Road | 16 | 35 | 18 | 19 |
| Maketawa S | opp Derby Road | (12) | (21) | (17) | (18) |
| Maketawa S | Tarata Road | (12) | (21) | (17) | (18) |
| Waitara R | Mamaku Road | 13 | 34 | 40 | 70 |
| Mangati S | D/s railway line | (10) | (17) | (10) | (64) |
| Mangati S | Te Rima Pl, Bell Block | (10) | (17) | (10) | (64) |
| Waimoku S | Lucy's Gully | (6) | (17) | (11) | (12) |
| Waimoku S | Beach | (6) | (17) | (11) | (12) |
| Waiau S | Inland North Road | (25) | (81) | (9) | (63) |
| Punehu S | Wiremu Rd | 7 | 14 | 35 | 55 |
| Punehu S | SH45 | 7 | 14 | 35 | 55 |
| Patea R | Barclay Rd | 8 | 22 | 40 | 41 |
| Patea R | Swansea Rd | 8 | 22 | 40 | 41 |
| Patea R | Skinner Rd | 8 | 22 | 40 | 41 |
| Mangaehu R | Raupuha Road | 7 | 22 | 50 | 99 |
| Mangawhero S | u/s Eltham WWT Plant | (10) | (29) | (62) | (63) |
| Mangawhero S | d/s Mangawharawhara S | (10) | (29) | (62) | (63) |
| Waingongoro R | 900m d/s Nat Park | 9 | 17 | 42 | 54 |
| Waingongoro R | Opunake Rd | 9 | 17 | 42 | 54 |
| Waingongoro R | Eltham Rd | 9 | 17 | 42 | 54 |
| Waingongoro R | Stuart Rd | 9 | 17 | 42 | 54 |
| Waingongoro R | SH45 | 9 | 26 | 53 | 146 |
| Waingongoro R | Ohawe Beach | 9 | 26 | 53 | 146 |
| Huatoki S | Hadley Drive | (18) | (74) | (30) | (52) |
| Huatoki S | Huatoki Domain | (18) | (74) | (30) | (52) |
| Huatoki S | Molesworth St | (18) | (74) | (30) | (52) |
| Kaupokonui R | Opunake Rd | 8 | 15 | 60 | 143 |
| Kaupokonui R | U/s Kaponga oxi ponds | 8 | 15 | 60 | 143 |
| Kaupokonui R | U/s Lactose Co. | 8 | 15 | 60 | 143 |
| Kaupokonui R | Glenn Rd | 8 | 15 | 60 | 143 |
| Kaupokonui R | Beach | 8 | 15 | 60 | 143 |
| Katikara S | Carrington Road | (7) | (32) | (11) | (15) |
| Katikara S | Near mouth | (7) | (32) | (11) | (15) |
| Kapoaiaia S | Wiremu Road | 9 | 17 | 14 | 15 |
| Kapoaiaia S | Wataroa Road | 9 | 17 | 14 | 15 |
| Kapoaiaia S | Near coast | 9 | 17 | 14 | 15 |
| Kurapete S | u/s Inglewood WWTP | (25) | (81) | (9) | (63) |
| Kurapete S | 6km d/s Inglewood WWTP | (25) | (81) | (9) | (63) |
| Tangahoe R | Upper Valley | (7) | (16) | (59) | (69) |
| Tangahoe R | Tangahoe Valley Road | (7) | (16) | (59) | (69) |
| Tangahoe R | d/s railbridge | (7) | (16) | (59) | (69) |
| Waiokura S | Skeet Road | (16) | (30) | (144) | (158) |
| Waiokura S | Manaia Golf-Course | (16) | (30) | (144) | (158) |
| Herekawe S | Centennial Drive | (18) | (74) | (18) | (72) |

NB: ( ) = extrapolation from nearby catchment

Spot water temperatures recorded at each site at the time of sampling during spring 2014 and summer 2015 SEM biomonitoring surveys are summarised in Table 5.

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

| Watercourse | Spring 2014 | Summer 2015 |
|---|---|---|
| Hangatahua (Stony) River | 18.2-18.4 | 13.6-15.2 |
| Timaru Stream | 14.6-18.2 | 12.4-14.2 |
| Mangaoraka Stream | 13.8 | 19.1 |
| Waiongana Stream | 16.0-17.9 | 16.3-18.6 |
| Waiwhakaiho River | 10.4-14.2 | 11.5-18.4 |
| Mangorei Stream | 13.6 | 16.3 |
| Manganui River | 17.6-18.6 | 16.3-18.3 |
| Maketawa Stream | 16.4-18.2 | 13.5-16.5 |
| Waitara River | 17.2 | 20.4 |
| Mangati Stream | 12.7-14.0 | 15.2-17.0 |
| Waimoku Stream | 14.3-16.9 | 13.6-15.4 |
| Waiau Stream | 13.7 | 19.7 |
| Punehu Stream | 11.7-13.2 | 16.2-18.5 |
| Patea River | 10.5-14.3 | 11.0-15.9 |
| Mangaehu River | 16.4 | 19.0 |
| Mangawhero Stream | 13.2 | 17.0-18.4 |
| Waingongoro River | 7.8-15.7 | 12.0-21.7 |
| Huatoki Stream | 11.9-12.8 | 19.6-19.9 |
| Kaupokonui River | 9.2-14.1 | 12.3-19.1 |
| Katikara Stream | 9.9-13.3 | 12.2-15.6 |
| Kapoaiaia Stream | 8.5-11.2 | 12.8-18.4 |
| Kurapete Stream | 11.0-11.3 | 15.5-16.3 |
| Tangahoe River | 11.8-12.6 | 14.1-16.0 |
| Waiokura Stream | 12.4-13.0 | 14.4-15.8 |
| Herekawe Stream | 12.8 | 17.8 |

(Note: N/R = not recorded)

### 3.1.1 Water temperature

**Spring 2014**

The spring 2014 surveys were undertaken maintly in early spring following relatively short to moderate recessions of one to two weeks after freshes, or delayed into summer due to mid to late spring freshes. Spring surveys in nearly all streams were conducted from 7 to 18 days after moderate freshes while none were more than 25 days after freshes. Water temperatures ranged from 7.8˚C to 18.2˚C in the upper reaches and from 11.2˚C to 18.6˚C in the lower reaches of streams and rivers at the time of the surveys (Table 5).

**Summer 2015**

Generally, rivers and streams were in relatively to very low recession flow following a few January 2015 freshes with drier conditions occurring in February 2015 when all but two of the surveys were performed. All but four surveys were performed no less than 11 days after significant freshes, with most surveys two weeks or longer after significant (3x median) freshes and ten of these surveys, four weeks or more after the most recent 3x median fresh.

Water temperatures ranged from 11.0°C to 13.5°C in the upper reaches and from 15.6°C to 21.7°C in the lower reaches of streams and rivers at the time of the surveys (Table 5). These ranges tended to be typical of most past summer surveys.

## 3.2 Macroinvertebrate communities

Lists of the taxa found during spring 2014 and summer 2015 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 was not performed 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 large scale significant headwater erosion events were recorded between spring 2009 and summer 2014 but there was a headwater erosion event in February 2014. Bed-scouring and sedimentation effects continued to impact through this period (e.g. June 2011) and during the 2014-2015 period. The results of 'spring (2014)' and summer (2014-2015) surveys are presented in Table 126 and Table 127, Appendix I. (Note: the 'spring 2014' survey was delayed by wet weather events).

### 3.2.1.1 Mangatete Road site (STY000300)

#### 3.2.1.1.1 Taxa richness and MCI

Forty-one surveys have been undertaken in the Stony River at this mid-reach site between October 1995 and February 2014. 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 2014' and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Jan 2015 | | Mar 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| STY000300 | 41 | 1-21 | 10 | 64-160 | 113 | 8 | 108 | 14 | 106 |

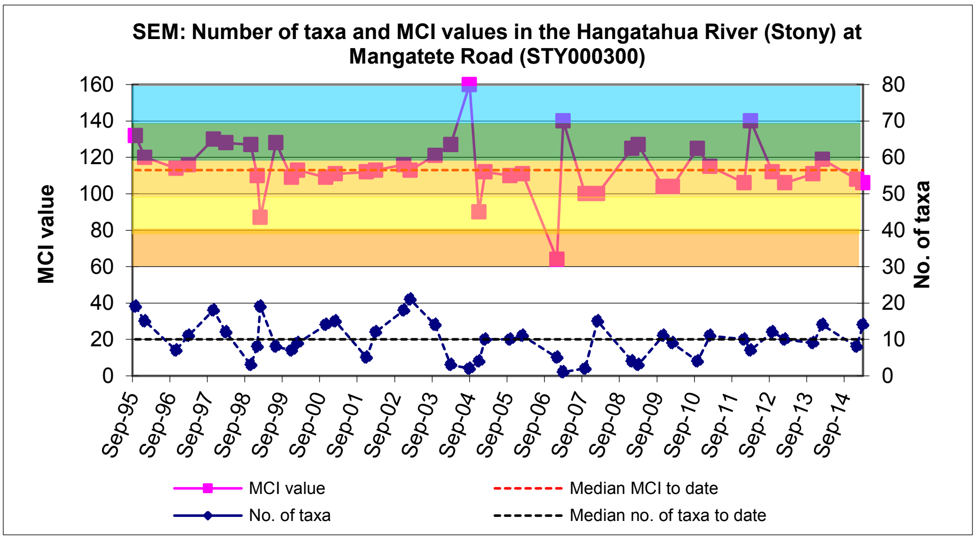



**Figure 2** Numbers of taxa and MCI values in the Hangatahua (Stony) River at Mangatete Road

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 2014-2015 period, richness was very slightly lower than this median in spring and four taxa more than this 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. The 2014-2015 scores (108 and 106 units) were very similar with the 'spring' score three units lower, and the summer score seven units lower, than the historical median. Spring and summer scores respectively categorised this site as having 'good' health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' (spring and summer) health for the mid-reaches of a ringplain river at the times of these surveys but the paucity of the communities in terms of richnesses in particular must be taken into account at the site, where headwater erosion effects have been very pronounced and the substrate remains relatively mobile and well-scoured. The historical median score (113 units) placed this site's river health in the 'good' and 'expected' categories.

#### 3.2.1.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [41 surveys] and by the 'spring 2014' and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | 'Spring 2014' | Summer 2015 |
| **ANNELIDA** | Oligochaeta | 1 | 1 | 2 | | |
| **EPHEMEROPTERA** | *Deleatidium* | 8 | 30 | 73 | VA | XA |
| **PLECOPTERA** | *Zelandoperla* | 8 | 14 | 34 | | A |
| **COLEOPTERA** | Elmidae | 6 | 12 | 29 | A | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 3 | 7 | | A |
| | *Costachorema* | 7 | 5 | 12 | | |
| | *Hydrobiosis* | 5 | 1 | 2 | | |
| | *Oxyethira* | 2 | 1 | 2 | | |
| **DIPTERA** | *Aphrophila* | 5 | 1 | 2 | | |
| | Eriopterini | 5 | 4 | 10 | | |
| | *Maoridiamesa* | 3 | 3 | 7 | | |
| | Orthocladiinae | 2 | 7 | 17 | | |

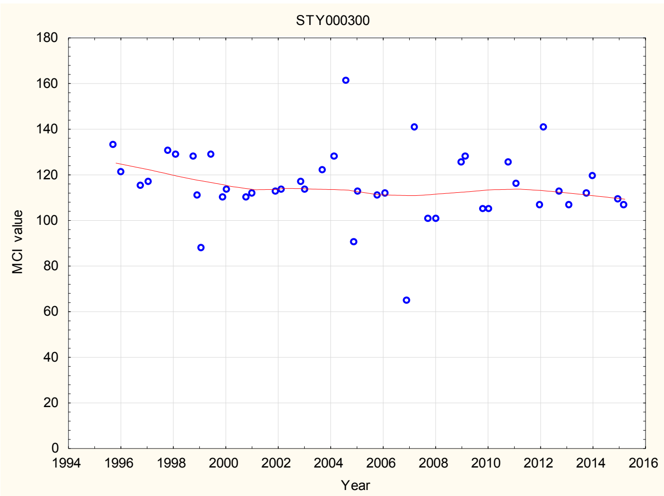
Prior to the current 2014-2015 period, twelve taxa have characterised this site's communities on survey occasions. These have comprised two 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa. The only predominant taxon has been the 'highly sensitive' taxon [ubiquitous mayfly (*Deleatidium*)]. 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). Only two of these characteristic taxa were dominant in the spring community and only these two and two other taxa were dominant in the summer community; both these results indicative of the significant reduction in diversity of characteristic taxa due to headwater erosion impacts and unstable substrate. The lack of abundances of midge taxa on both occasions was coincident with the presence of minimal periphyton mats cover on the cobble-boulder substrate; an indication of the instability of the substrate and limited recovery from scouring/erosion events. The relative similarity of the characteristic taxa on the two occasions and particularly the single numerically dominant taxon was reflected in the relatively small difference in $SQMCI_s$ scores of 0.3 unit between seasons (Tables 126 and 127), with the high values due to the numerical abundance and dominance of the mayfly (*Deleatidium*), particularly in summer.

#### 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, 2014' score was very similar to the distance and seven units higher than the altitude predictive values, while the summer, 2015 survey score was five units above to three units lower than the predictive values. Of the 43 surveys to date at this site, only 12% 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 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 43
Kendall tau = - 0.183
p level = 0.082 [>FDR, p = 0.129]
N/S at p <0.05

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

Although an overall slight decreasing trend in MCI scores has been found, particularly over the first six years, this has not been statistically significant. This site has a LOWESS-smoothed range of MCI scores of about 15 units indicative of some important ecological variability over the period, not surprisingly given the erosion effect documented earlier and further emphasised by the wide range of individual scores, particularly since 2004. Overall this smoothed trend line shows generic river 'health' (Table 1) deteriorating slightly from 'very good' (prior to 1999) 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 'better than expected' to '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

### 3.2.1.4 SH 45 site (STY000400)

#### 3.2.1.4.1 Taxa richness and MCI

Forty-one surveys have been undertaken in the Stony River at this lower reach site between October 1995 and February 2014. These results are summarised in Table 8, together with results from the current period, and illustrated in Figure 4.

**Table 8** Results from SEM surveys performed in the Stony River at SH 45 together with 'spring 2014' and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Jan 2015 | | Mar 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| STY000400 | 41 | 0-18 | 9 | 0-160 | 108 | 9 | 107 | 10 | 120 |

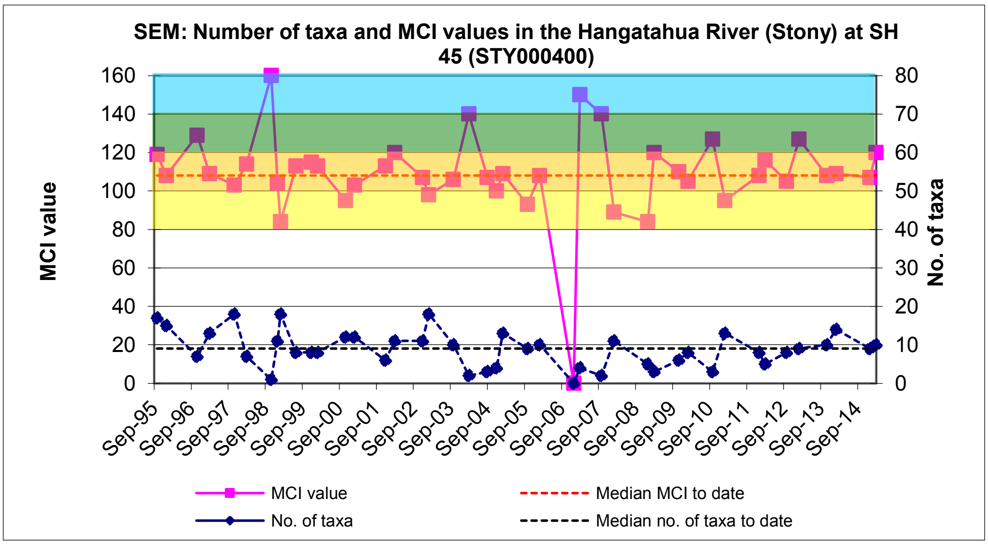



**Figure 4** Numbers of taxa and MCI values in the Hangatahua (Stony) River at SH 45

A wide range of richnesses (0 to 18 taxa) has been recorded mainly as a consequence of extensive headwater erosion impacts on the river's communities, with a median richness of only 9 taxa, far fewer than would be expected for a ringplain river site at this altitude (70 m asl) [eg median of 18 taxa (TRC, 2015a)]. In the 2014-2015 period richnesses were within one taxon of this site's historical median at the time of the two sampling occasions, but indicative of continuing erosion impacts of scouring, finer sediment deposition, and bed movement at this site.

While it is recognised that there may be significant limitations to the appropriateness of the MCI when community compositions are affected by sedimentation and erosion events (e.g. scores show considerable variability when relatively few taxa are present), values at this site have ranged widely between 0 and 160 units with a median MCI value of 108 units. The MCI score in 'spring, 2014' (107 units) was significantly lower than the score in summer, 2015 (120 units) and ranged from within one unit to 12 units above the historical median (Figure 4). They categorised this site as having 'good' ('spring') to 'very good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health in 'spring, 2014' and 'better than expected' health in summer, 2015 for the lower reaches of a ringplain river. The historical median score (108 units) categorised this site as having 'good' generic health, but 'better than expected' predictive health, for a lower river reach.

However, the paucity of numbers and richnesses (in both seasons) should be recognised in this assessment given the historical impacts of headwater erosion effects along the length of the river channel.

#### 3.2.1.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [41 surveys] and by the 'spring 2014' and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | 'Spring 2014' | Summer 2015 |
| **ANNELIDA** | Oligochaeta | 1 | 1 | 2 | | |
| **EPHEMEROPTERA** | *Deleatidium* | 8 | 29 | 71 | XA | XA |
| **PLECOPTERA** | *Zelandoperla* | 8 | 9 | 22 | | |
| **COLEOPTERA** | Elmidae | 6 | 5 | 12 | A | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 6 | 15 | | A |
| | *Costachorema* | 7 | 4 | 10 | A | |
| | *Hydrobiosis* | 5 | 4 | 10 | | |
| | *Oxyethira* | 2 | 1 | 2 | | |
| **DIPTERA** | *Aphrophila* | 5 | 1 | 2 | | |
| | Eriopterini | 5 | 1 | 2 | | |
| | *Maoridiamesa* | 3 | 3 | 7 | | |
| | Orthocladiinae | 2 | 9 | 22 | A | |

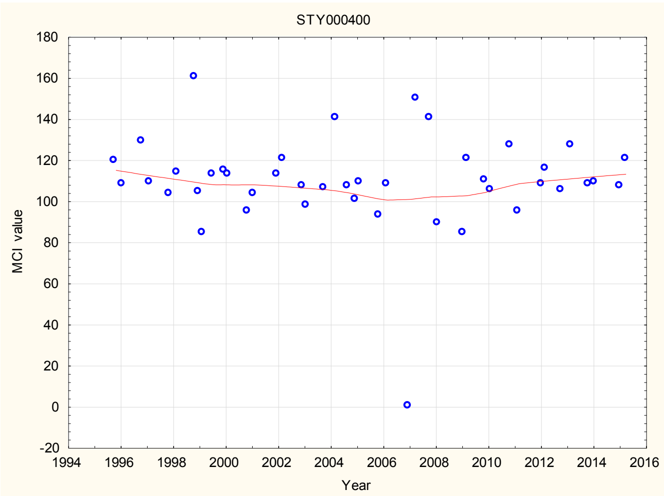
Prior to the current 2014-2015 period, twelve taxa have characterised this site's communities on survey occasions. These have been comprised of two 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa. Only one taxon has been predominant; a 'highly sensitive' taxon [the ubiquitous mayfly (*Deleatidium*)]. This taxon is often present on unstable shingle-cobble substrates (Death, 2000) and during recovery from erosion/siltation events (Fowles, 1987). Only four of the characteristic taxa were dominant in the 'spring' community [and three in the summer community, with the mayfly taxon (*Deleatidium*) extremely abundant in both 'spring' and summer communities. Both these results were indicative of a paucity of characteristic taxa due to preceding headwater erosion impacts and/or substrate instability. The relative paucity of midge taxa recorded in both seasons was consistent with only thin periphyton mat layers on the mobile cobble-boulder substrate. The overall dominance by the one 'highly sensitive' taxon was reflected in the very similar, high 'spring' and summer $SQMCI_s$ scores which were within 0.2 unit.

#### 3.2.1.4.3 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 five units above the distance predictive value while the 'spring, 2014' and summer 2015 surveys' scores were both significantly higher than the altitude predictive value and also four to a significant 17 units higher than the distance predictive value. Of the 43 surveys to date at this site, only 7% of MCI scores have been less than 92 units while 74% have been greater than 103 units.

#### 3.2.1.4.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 43
Kendall tau = - 0.026
p level = 0.807 [>FDR, p = 0.857]
N/S at p <0.05

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

An overall slightly decreasing trend in MCI scores over the period has not been statistically significant. The site has a LOWESS-smoothed MCI range of about 16 units indicative of some important ecological variability over the period for the same reasons as those responsible for variability at the upstream site (Mangatete Rd). Overall, smoothed scores have shown generic river 'health' (Table 1) within the 'good' category while, in terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain river, 'health' has deteriorated slightly from 'better than expected' to 'expected' before a more recent gradual 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.

### 3.2.1.5 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 at each site showed variable differences between spring and in summer, with a decrease in score at the downstream site of one unit under 'spring' conditions and an atypical increase of 13 units under summer conditions, the paucity of the communities at both sites should be noted on both seasonal occasions.

MCI scores typically (slightly) decreased in a downstream direction in spring over a distance of 5.2 km, equating to an average rate of decline of 0.4 unit/km which was much lower than the predicted average rate (1.15 units/km) over the equivalent length of a National Park-sourced river (Stark and Fowles, 2009). Atypically, MCI scores increased in a downstream direction under summer low flow conditions.

## 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 2014-2015 surveys are presented in Table 128 and 129, Appendix I. (Note: The 'spring 2014' survey was delayed by a period of wet weather events).

### 3.2.2.1 Carrington Road site (TMR000150)

#### 3.2.2.1.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken at this upper reach site in the Timaru Stream inside the National Park boundary at Carrington Road between October 1995 and February 2014. 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 2014' and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Jan 2015 | | Mar 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| TMR000150 | 38 | 8-32 | 26 | 119-144 | 137 | 33 | 139 | 25 | 138 |

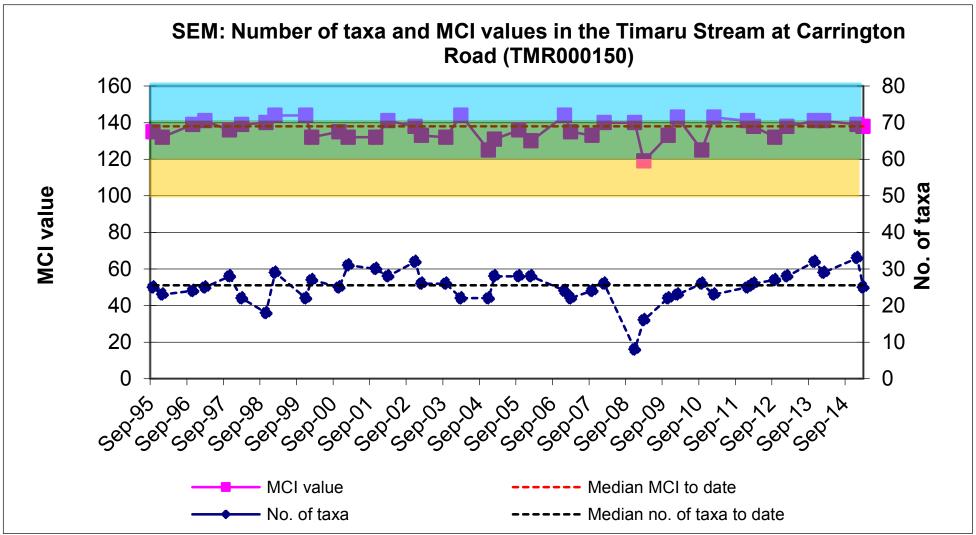



**Figure 6** Numbers of taxa and MCI values in the Timaru Stream at Carrington Road

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 which markedly reduced richness. A median richness of 25 taxa (slightly below that representative of typical richnesses in ringplain streams and rivers near the National Park boundary (TRC, 2015a)) has been found to February 2014. During the 2014-2015 period, 'spring' (33 taxa) and summer (25 taxa) richnesses were well above ('spring') and similar to (summer) this median richness and indicative of recovery from earlier 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 the atypically low value (119 units) after the 2008-2009 headwater erosion period. The median value (137 units) has been typical of upper reach sites elsewhere on the ringplain however. The 'spring, 2014' score (139 units) and the summer, 2015 score (138 units) were relatively typical for such a site, and close to 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), 'expected' health for the upper reaches of a ringplain stream on both of these occasions. The historical median score (137 units) placed this site in the 'very good' category for the generic, and '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 2014-2015 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 2014 [38 surveys], and by the 'spring 2014' and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | 'Spring 2014' | Summer 2015 |
| EPHEMEROPTERA | *Austroclima* | 7 | 4 | 11 | | |
| | *Coloburiscus* | 7 | 29 | 76 | VA | VA |
| | *Deleatidium* | 8 | 38 | 100 | XA | VA |
| | *Nesameletus* | 9 | 34 | 89 | A | |
| PLECOPTERA | *Acroperla* | 5 | 4 | 11 | | |
| | *Megaleptoperla* | 9 | 0 | 0 | A | |
| | *Stenoperla* | 10 | 2 | 5 | | |
| | *Zelandobius* | 5 | 28 | 74 | | |
| | *Zelandoperla* | 8 | 26 | 68 | VA | |
| COLEOPTERA | Elmidae | 6 | 16 | 42 | A | A |
| MEGALOPTERA | *Archichauliodes* | 7 | 1 | 3 | A | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 0 | 0 | | A |
| | *Costachorema* | 7 | 2 | 5 | | |
| | *Hydrobiosis* | 5 | 1 | 3 | | |
| | *Hydrobiosella* | 9 | 3 | 8 | | |
| | *Hydropsyche (Orthopsyche)* | 9 | 2 | 5 | | |
| | *Beraeoptera* | 8 | 5 | 13 | | A |
| | *Helicopsyche* | 10 | 5 | 13 | | |
| | *Olinga* | 9 | 0 | 0 | A | A |
| DIPTERA | *Aphrophila* | 5 | 12 | 32 | A | A |
| | *Maoridiamesa* | 3 | 4 | 11 | | |
| | Orthocladiinae | 2 | 21 | 55 | | A |

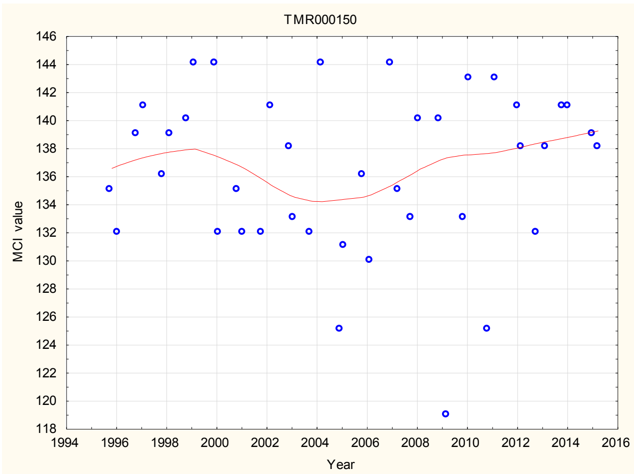
Prior to the current 2014-2015 period, 19 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', nine 'moderately sensitive', and two 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected near the National Park boundary of a ringplain 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). Nine taxa were dominant in the 'spring, 2014' community and these included five 'highly sensitive' and four 'moderately sensitive' taxa. Two of these 'highly sensitive' taxa [stonefly (*Megaleptoplerla*) and cased caddisfly (*Olinga*)] had not been found in abundance previously at this site. Six of these taxa were again dominant in the summer, 2015 community together with one additional 'highly sensitive' taxon and two 'tolerant' taxa and three fewer 'highly sensitive' taxa. One of these 'tolerant' taxa [caddisfly (*Hydropsyche-Aoteapsyche*)] had not been found in abundance previously at this site. Significant changes in abundances within several characteristic taxa between seasonal communities composition's were reflected in a moderate difference in seasonal $SQMCI_s$ values of 0.8 unit (Tables 128 and 129). Those taxa recorded as very or extremely abundant during 'spring' and/or summer had characterised this site's communities on 68% to 100% of past survey occasions.

### 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 (138 units) is a significant 11 units higher than the altitude prediction and six units higher than the distance predictive values. The 'spring 2014' score (139 units) was seven to a significant (Stark, 1998) 12 units higher than these predictive values and the summer score (138 units) was five to ten units above these predictive values. Of the 40 surveys to date at this site, only 8% of MCI scores have been less than 127 units while 73% have been greater than 132 units.

### 3.2.2.1.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.023
p level = 0.828 [>FDR, p = 0.861]
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 upwards in general, with a more recent improvement, since 2006, but the trend has not been statistically significant over the period. The LOWESS-smoothed MCI scores have ranged over five units which has not been ecologically important. 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 within the 'expected' category throughout the twenty year period.

#### 3.2.2.2 SH45 site (TMR000375)

##### 3.2.2.2.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Timaru Stream at this lower, mid-reach site at SH45 between October 1995 and February 2014. 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 2014' and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Jan 2015 | | Mar 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| TMR000375 | 38 | 13-35 | 27 | 89-120 | 103 | 25 | 102 | 26 | 92 |

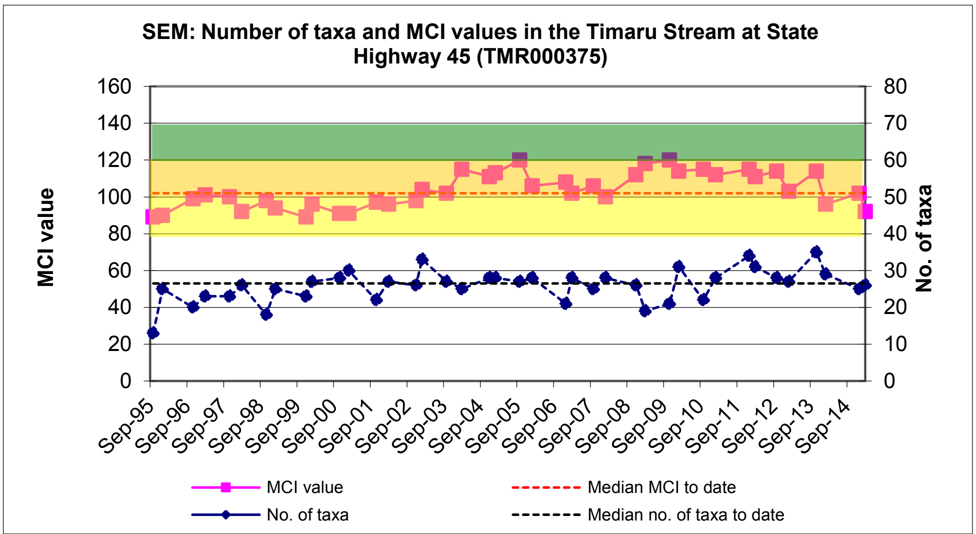



**Figure 8** Numbers of taxa and MCI values in the Timaru Stream at State Highway 45

A wide range of richnesses (13 to 34 taxa) has been found; wider than might be expected, with a median richness of 27 taxa (higher than typical richnesses in the mid reaches of ringplain streams and rivers (TRC, 2015a)). During the 2014-2015 period 'spring' (25 taxa) richness was two taxa fewer and the similar summer (26 taxa) richness was one taxon lower than the historical median taxa number, coincident with patchy substrate periphyton cover (mats and filamentous algae) in summer and more widespread filamentous algae in 'spring'.

MCI values have had a slightly wider range (31 units) at this site than typical of sites in the mid reaches of ringplain streams. The median value (103 units) has been relatively typical of mid reach sites elsewhere on the ringplain however, with the 'spring 2014' (102 units) score very similar to the historical median in 'spring' but significantly (Stark, 1998) lower (by 11 units) in summer. The summer score was amongst the lowest scores recorded at this site, particularly since 2003. These scores categorised this site as having 'good' ('spring') and 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health in both 'spring' and summer for the lower mid reaches of a ringplain stream. The historical median score (102 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 2014-2015 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 2014 [38 surveys], and by the 'spring 2014' and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | 'Spring 2014' | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 1 | 3 | | |
| ANNELIDA | Oligochaeta | 1 | 13 | 34 | | |
| MOLLUSCA | *Potamopyrgus* | 4 | 4 | 11 | | A |
| EPHEMEROPTERA | *Austroclima* | 7 | 14 | 37 | | |
| | *Coloburiscus* | 7 | 24 | 63 | | A |
| | *Deleatidium* | 8 | 17 | 45 | | |
| | *Rallidens* | 9 | 2 | 5 | | |
| PLECOPTERA | *Acroperla* | 5 | 5 | 13 | | |
| | *Zelandobius* | 5 | 3 | 8 | | |
| | *Zelandoperla* | 8 | 17 | 45 | | |
| COLEOPTERA | Elmidae | 6 | 21 | 55 | | A |
| MEGALOPTERA | *Archichauliodes* | 7 | 18 | 47 | A | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 35 | 92 | A | VA |
| | *Costachorema* | 7 | 11 | 29 | | |
| | *Hydrobiosis* | 5 | 8 | 21 | | A |
| | *Neurochorema* | 6 | 8 | 21 | | |
| | *Beraeoptera* | 8 | 7 | 18 | | |
| | *Confluens* | 5 | 1 | 3 | | |
| | *Oxyethira* | 2 | 7 | 18 | | A |
| | *Pycnocentrodes* | 5 | 17 | 45 | A | A |
| DIPTERA | *Aphrophila* | 5 | 36 | 95 | A | |
| | *Maoridiamesa* | 3 | 29 | 76 | A | A |
| | Orthocladiinae | 2 | 36 | 95 | A | A |
| | Tanytarsini | 3 | 9 | 24 | | A |
| | Empididae | 3 | 5 | 13 | | |
| | Muscidae | 3 | 4 | 11 | | A |
| | *Austrosimulium* | 3 | 13 | 34 | A | |

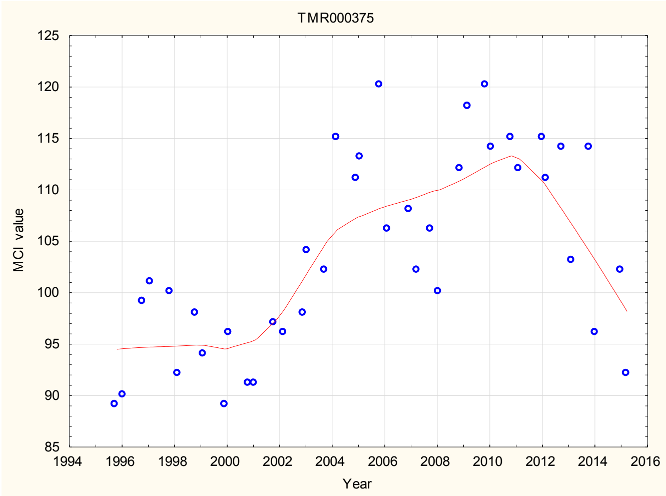
Prior to the current 2014-2015 period, a relatively large number (27) taxa had characterised the community at this site on occasions. These have comprised four 'highly sensitive', twelve 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increase in the proportion of 'tolerant' taxa as would be expected in the mid reaches compared with the upper reaches of a ringplain stream. Predominant taxa have included no 'highly sensitive' taxa, three 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, and cranefly (*Aphrophila*)], and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)]. Seven of the historically characteristic taxa were dominant in the 'spring 2014' community. These comprised three 'moderately sensitive' and four 'tolerant' taxa; whereas five 'moderately sensitive' and seven 'tolerant' taxa comprised the dominant taxa of the summer community when 'tolerant' taxa proportionally were similarly dominant. Although only five of these 14 taxa were dominant in both spring and summer communities (Table 13), the similarity in ratios of 'moderately sensitive' to 'tolerant' taxa were reflected in the seasonal $SQMCI_s$ scores (Table 128 and 129) which decreased by only 0.1 unit in summer. The only taxaon recorded as very or extremely abundant during 'spring' and/or summer had characterised this site's communities on 92% of past survey occasions

#### 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 (102) is seven units higher than the altitude prediction and three units lower than the distance predictive value. The 'spring' survey score (102 units) was also seven units higher than the altitude predictive value and three units lower than the predictive distance value while the summer score (92 units) was slightly lower than the predictive altitude value but a significant 13 units lower than predictive distance value. Of the 40 surveys to date at this site, 20% of MCI scores have been less than 95 units while 43% have been greater than 105 units.

#### 3.2.2.2.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.409
p level < 0.0002 [>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 18 units, an ecologically important 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', but there has been a very recent return to the 'fair' category. 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 until very recently.

### 3.2.2.3 Discussion

Seasonal MCI values typically remained very similar between 'spring' and summer at the National Park boundary site where historical median scores have been within two units (Appendix II), over the 20 year period, whereas a greater summer decrease of 10 units was found at the lower mid reach site where a difference of two units in seasonal historical median scores has been found (Appendix II). The percentage composition by 'tolerant' taxa increased (by 6%) in the summer community at the lower mid reach site. Seasonal communities at the upper site shared 20 common taxa (53% of the 38 taxa found at this site in 2014-2015), a moderate but lower percentage than typical of communities at an upper reach site. This compared with 21 shared common taxa (70% of the 30 taxa found in 2014-2015) at the lower mid reaches site (SH45), a much less pronounced seasonal change in community structure at the further downstream site. The two sites shared 14 common taxa (32% of the 44 taxa at upper and mid reach sites) in 'spring' and 10 common taxa (23% of 41 taxa) in summer, indicative of the dissimilarity in spatial community structures in 'spring' and typically more so in summer.

MCI score typically fell in a downstream direction in both 'spring' (by 37 units) and in summer (by 46 units), over a stream distance of 10.9 km downstream from the National Park boundary. These equated to average rates of decline of 3.4 units/km in 'spring' increasing to 4.2 units/km in summer, compared with a predicted average rate of 2.4 units/km over the equivalent length and reach of a National Park-sourced stream (Stark and Fowles, 2009); a markedly more higher rate in summer.

Using the long-term (20 year) median SEM MCI scores for both sites (Appendix II), the average rate of decline between the upper and lower reach sites has been 3.3 units/km over the surveyed length. Therefore average rates of decline were similar in 'spring' and much higher in summer of the 2014-2015 period than the median average rate for the period to date.

### 3.2.3 Mangaoraka Stream

The results found by the 2014-2015 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-eight surveys have been undertaken at this lower reach site in the Mangaoraka Stream between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MRK000420 | 38 | 11-30 | 25 | 75-105 | 90 | 27 | 90 | 25 | 85 |

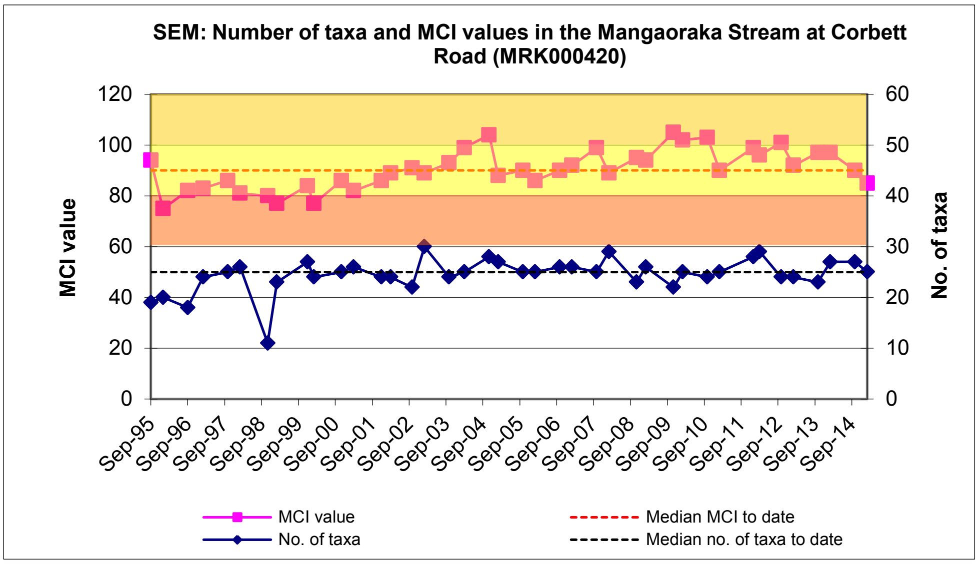



**Figure 10** Numbers of taxa and MCI values in the Mangaoraka Stream at Corbett Road

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 2014-2015 period spring (27 taxa) and summer (25 taxa) richnesses were similar and within two taxa of this median richness.

MCI values have also had a relatively wide range (30 units) at this site to date. The median value (90 units) has been typical of lower reach sites elsewhere on the ringplain (TRC, 2015a) however, with the spring, 2014 (90 units) and summer 2015 (85 units) scores more typical for such a site and up to five units below the historical median. These scores categorised this site as having ‘fair’ (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), ‘expected’ (spring and summer) health for the lower reaches of a ringplain stream on these occasions. The historical median score (90 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

#### 3.2.3.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 period are listed in Table 15.

**Table 15** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Mangaoraka Stream at Corbett Road, between 1995 and February 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **PLATYHELMINTHES** | *Cura* | 3 | 1 | 3 | | |
| **NEMERTEA** | Nemertea | 3 | 5 | 13 | | A |
| **ANNELIDA** | Oligochaeta | 1 | 29 | 76 | A | A |
| **MOLLUSCA** | *Latia* | 5 | 2 | 5 | | |
| | *Physa* | 3 | 1 | 3 | | |
| | *Potamopyrgus* | 4 | 33 | 87 | | VA |
| **CRUSTACEA** | Ostracoda | 1 | 1 | 3 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 23 | 61 | | |
| | *Coloburiscus* | 7 | 4 | 11 | | |
| | *Deleatidium* | 8 | 7 | 18 | | |
| | *Zephlebia group* | 7 | 3 | 8 | | |
| **PLECOPTERA** | *Zelandobius* | 5 | 14 | 37 | A | |
| **COLEOPTERA** | Elmidae | 6 | 26 | 68 | VA | VA |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 18 | 47 | A | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 33 | 87 | VA | VA |
| | *Costachorema* | 7 | 3 | 8 | | |
| | *Hydrobiosis* | 5 | 28 | 74 | A | |
| | *Neurochorema* | 6 | 3 | 8 | | |
| | *Oxyethira* | 2 | 6 | 16 | | |
| | *Pycnocentria* | 7 | 2 | 5 | | |
| | *Pycnocentrodes* | 5 | 27 | 71 | | A |
| **DIPTERA** | *Aphrophila* | 5 | 21 | 55 | | |
| | *Maoridiamesa* | 3 | 9 | 24 | A | |
| | Orthocladiinae | 2 | 30 | 79 | | A |
| | Tanytarsini | 3 | 10 | 26 | | A |
| | Empididae | 3 | 6 | 16 | | |
| | Muscidae | 3 | 2 | 5 | | |
| | *Austrosimulium* | 3 | 11 | 29 | A | |

Prior to the current 2014-2015 period, 28 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', 13 'moderately sensitive', and 14 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream.

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

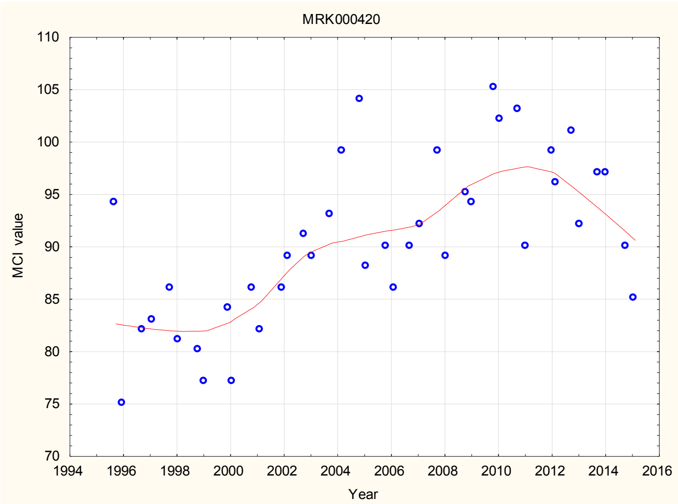
Eight of the historically characteristic taxa were dominant in the spring, 2014 community comprising four of the predominant taxa (above) together with another two 'moderately sensitive' and two 'tolerant' taxa. The summer, 2015 community was characterised by four of the taxa dominant in spring, together with an additional one 'moderately sensitive' and five 'tolerant' taxa, three of which previously had been characteristic of this site's communities (Table 15) but two fewer of the 'sensitive' taxa and one fewer of the 'tolerant' taxa dominant in spring. The decrease in 'sensitive' summer dominant taxa and increase in dominant 'tolerant' taxa were reflected in the small summer decrease in $SQMCI_s$ scores of 0.4 unit (Tables 130 and 131). The taxa which were recorded as very abundant during spring and/ or summer had characterised this site's communities on 68% 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 (90 units) is only one unit below this altitude prediction while the spring score (90 units) and summer score (85 units) were both insignificantly below this predictive value. Of the 40 surveys to date at this site, 65% of MCI scores have been less than 91 units, indicating that the current spring and summer MCI scores were more typical of historical conditions.

#### 3.2.3.1.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = + 0.478
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 ($p < 0.001$ after FDR), particularly since 1999 with the trend tending to plateau between 2003 and 2007 before improving further, plateauing in 2011, and deteriorating slightly very recently. However, the latest scores remain above most scores recorded prior to 2000. The trend was statistically significant after FDR application. The LOWESS-smoothed scores have varied over an ecologically important range of 16 units during the period. SEM physicochemical monitoring at this site had illustrated significant improvements in aspects of organic loadings at this site in the lower reaches of the stream prior to mid 2008. This was coincident with more rigorous surveillance monitoring of nearby quarrying and waste disposal activities and good dairy shed wastewater disposal compliance performance during that period although more recently, aspects of poorer overall water quality (i.e. increased bacteriological numbers and increasing trends in certain nutrient species) have been recorded (TRC, 2014) despite the apparent improvement in biological communities.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) throughout the period improving toward 'good' more recently (2011) 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 (which has been maintained since 2003) over the twenty year period.

#### 3.2.3.2 Discussion

Seasonal MCI values typically decreased between spring and summer at this lower reach site, similar to the historical median summer decrease (three units) in scores (Appendix II). The percentage composition of 'tolerant' taxa increased by 12% in the summer community when filamentous algal substrate cover was more extensive . Seasonal communities at this site shared a relatively high number of common taxa (21 taxa; 68% of the 31 taxa found at this site in 2014-2015), but the increase in the proportion of 'tolerant' taxa in summer decreased MCI values by five units between seasons.

### 3.2.4 Waiongana Stream

The results found by the 2014-2015 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-nine surveys have been undertaken at this mid reach site in the Waiongana Stream between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to March 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Dec 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WGA000260 | 39 | 12-30 | 24 | 82-112 | 96 | 28 | 99 | 28 | 96 |

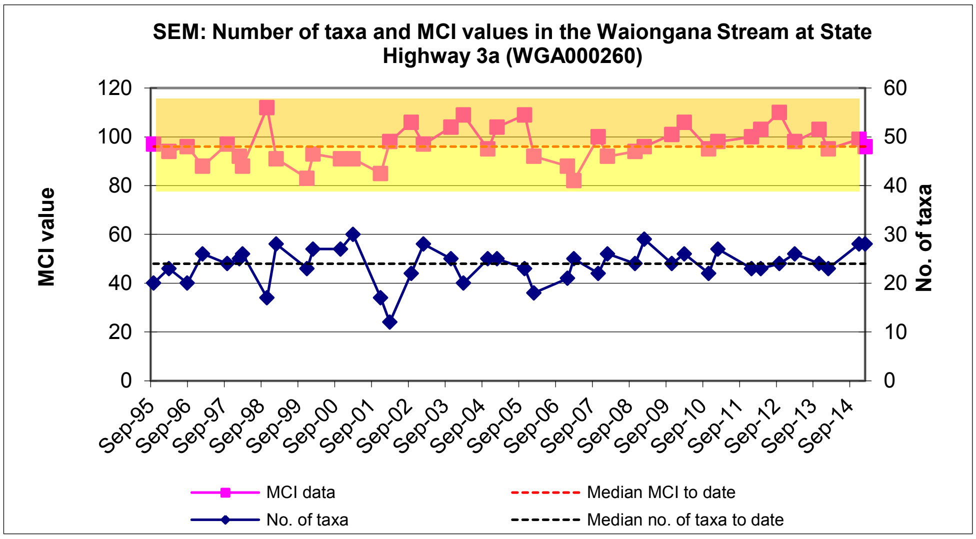



**Figure 12** Numbers of taxa and MCI values in the Waiongana Stream at State Highway 3A

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 2014-2015 period, spring (28 taxa) and summer (28 taxa) richnesses were identical and four taxa above this median richness.

MCI values have also had a relatively wide range (30 units) at this site, relatively typical of a site in the mid reaches of a ringplain stream. The median value (96 units) also has been typical of mid-reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (99 units) and summer, 2015 (96 units) scores were relatively similar and three units above (spring) and equal with (summer) the historical median. These scores categorised this site as having ‘fair’ (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), ‘expected’ health for the mid reaches of a ringplain stream in spring and in summer. The historical median score (96 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 2014-2015 period are listed in Table 17.

**Table 17** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiongana Stream at SH3a between 1995 and February 2014 [39 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 2 | 5 | | |
| ANNELIDA | Oligochaeta | 1 | 20 | 51 | A | |
| MOLLUSCA | *Potamopyrgus* | 4 | 16 | 41 | A | A |
| CRUSTACEA | *Paracalliope* | 5 | 1 | 3 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 4 | 10 | | |
| | *Coloburiscus* | 7 | 4 | 10 | | |
| | *Deleatidium* | 8 | 20 | 51 | A | |
| COLEOPTERA | Elmidae | 6 | 30 | 77 | VA | XA |
| MEGALOPTERA | *Archichauliodes* | 7 | 11 | 28 | A | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 64 | A | VA |
| | *Costachorema* | 7 | 13 | 33 | | |
| | *Hydrobiosis* | 5 | 18 | 46 | A | A |
| | *Neurochorema* | 6 | 2 | 5 | | A |
| | *Oxyethira* | 2 | 9 | 23 | | |
| | *Pycnocentrodes* | 5 | 12 | 31 | A | |
| DIPTERA | *Aphrophila* | 5 | 33 | 85 | A | A |
| | *Maoridiamesa* | 3 | 26 | 67 | A | A |
| | Orthocladiinae | 2 | 34 | 87 | VA | XA |
| | Tanytarsini | 3 | 14 | 36 | A | A |
| | Empididae | 3 | 6 | 15 | | A |
| | Muscidae | 3 | 6 | 15 | | |
| | *Austrosimulium* | 3 | 3 | 8 | | |

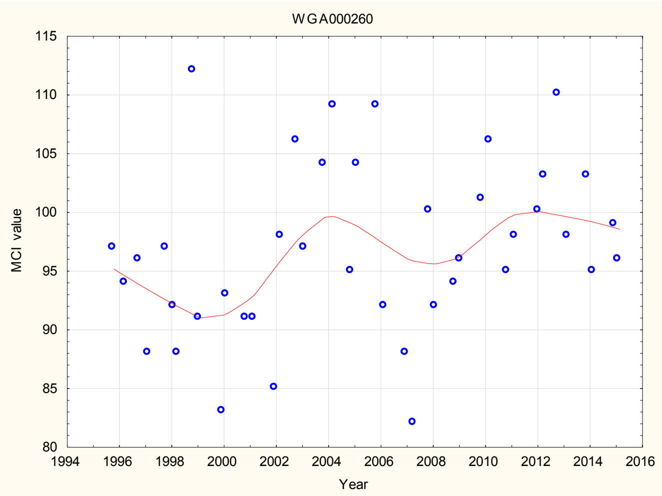
Prior to the current 2014-2015 period, 22 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and eleven 'tolerant' taxa i.e. a relatively even balance of 'sensitive' and 'tolerant' taxa as would be expected in the mid-reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)], two 'moderately sensitive' taxa [elmid beetles and cranefly (*Aphrophila*)], and four 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. All seven of these predominant taxa were dominant in the spring, 2014 community together with five (three 'moderately sensitive' and two 'tolerant' taxa) of the other historically characteristic taxa. The summer, 2015 community was characterised by nine of the taxa dominant in spring, together with an additional one 'moderately sensitive' and one 'tolerant' taxa, all of which previously had been characteristic of this site's communities on occasions (Table 17), and one fewer 'highly sensitive', one fewer 'moderately sensitive', and one fewer 'tolerant' taxa. Increases in the numerical abundances of two 'tolerant' taxa in particular were reflected in the small summer decrease of 0.3 unit in $SQMCI_s$ scores (Tables 132 and 133).The three taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 64% to 87% of past survey occasions.

#### 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 (96 units) is three units lower than the altitude prediction and four units below the distance predictive value, while the spring, 2014 survey score (99 units) was within one unit of both predictive values while the summer, 2015 score (96 units) was three to four units lower than both predictive values. Of the 41 surveys to date at this site, 66% of MCI scores have been less than 99 units while only 24% have been greater than 100 units.

#### 3.2.4.1.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 41
Kendall tau = +0.224
p level = 0.039 [>FDR, p = 0.069]
Significant at $p < 0.05$
N/S after FDR

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

There has been a positive overall trend in the MCI scores identified, which has not been statistically significance after FDR (at $p < 0.05$). There has been a steady improvement in scores between 2001 and 2004 followed by a decline in scores until 2008, and another steady increase more recently. This site's scores have had a LOWESS-smoothed range of nine units indicative of marginal ecologically important variability over the period.

Overall, smoothed scores remained indicative of 'fair' generic stream health (Table 1) for the majority of the period, improving toward 'good' 'health' briefly in 2004 and again between 2011and 2012. 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 twenty year period, bordering on 'worse than expected' for a short period in 1998-2001.

### 3.2.4.2 Devon Road site (WGA000450)

#### 3.2.4.2.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken at this lower reach site at SH45 in the Waiongana Stream between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Dec 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WGA000450 | 38 | 12-29 | 22 | 72-102 | 90 | 24 | 92 | 24 | 89 |

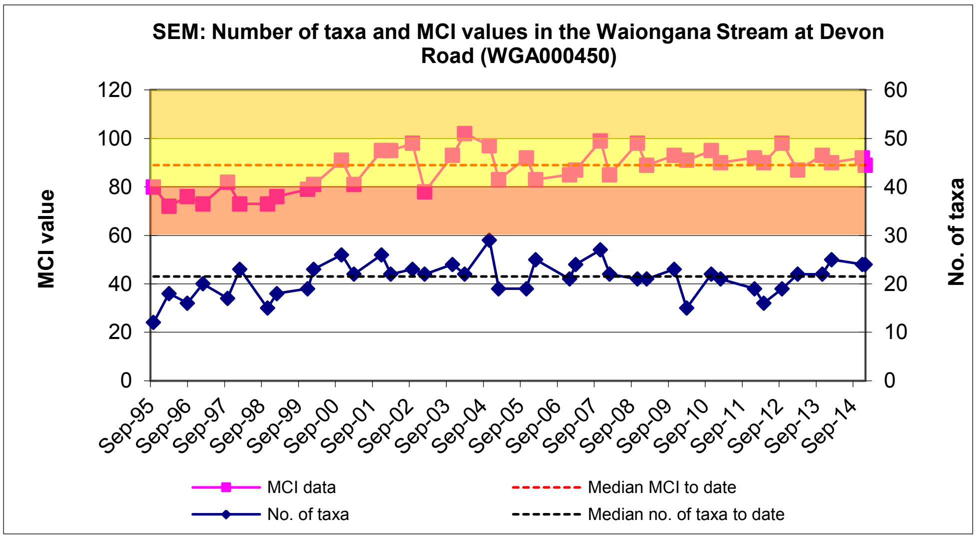



**Figure 14** Numbers of taxa and MCI values in the Waiongana Stream at Devon Road

A wide range of richness (12 to 29 taxa) has been found with a median richness of 22 taxa, more representative of typical richnesses in ringplain streams and rivers in the lower reaches. During the 2014-2015 period, spring (24 taxa) and summer (24 taxa) richnesses were identical and two taxa above the median taxa number.

MCI scores have had a relatively wide range (30 units) at this site typical of sites in the lower reaches of ringplain streams. The median value (90 units) also has been typical of lower reach sites elsewhere on the ringplain (TRC, 2015a), with the spring, 2014 (92 units) and summer, 2015 (89 units) scores within the range typical for such a site and within two units of the historical median score. These scores categorized this site as having 'fair' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health on both occasions for the lower reaches of a ringplain stream. The historical median score (90 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 2014-2015 period are listed in Table 19.

**Table 19** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiongana Stream at Devon Road between 1995 and February 2014 [38 surveys], by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 3 | 8 | | |
| ANNELIDA | Oligochaeta | 1 | 29 | 76 | A | A |
| MOLLUSCA | *Ferrissia* | 3 | 1 | 3 | | |
| | *Latia* | 5 | 2 | 5 | | |
| | *Potamopyrgus* | 4 | 24 | 63 | A | XA |
| CRUSTACEA | *Paracalliope* | 5 | 2 | 5 | | |
| | *Paratya* | 3 | 1 | 3 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 4 | 11 | | |
| | *Deleatidium* | 8 | 8 | 21 | | |
| PLECOPTERA | *Zelandobius* | 5 | 1 | 3 | | |
| COLEOPTERA | Elmidae | 6 | 19 | 50 | A | VA |
| MEGALOPTERA | *Archichauliodes* | 7 | 7 | 18 | | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 66 | VA | VA |
| | *Costachorema* | 7 | 2 | 5 | | |
| | *Hydrobiosis* | 5 | 15 | 39 | | A |
| | *Neurochorema* | 6 | 2 | 5 | | A |
| | *Oxyethira* | 2 | 8 | 21 | | |
| | *Pycnocentrodes* | 5 | 17 | 45 | | VA |
| DIPTERA | *Aphrophila* | 5 | 17 | 45 | A | |
| | *Maoridiamesa* | 3 | 16 | 42 | VA | |
| | Orthocladiinae | 2 | 32 | 84 | A | VA |
| | Tanytarsini | 3 | 13 | 34 | | A |
| | Empididae | 3 | 1 | 3 | | |
| | Muscidae | 3 | 3 | 8 | | |
| | *Austrosimulium* | 3 | 6 | 16 | | |

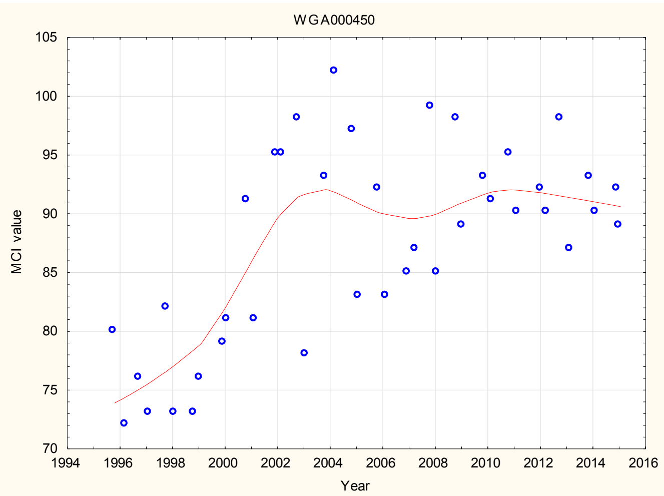
Prior to the current 2013-2014 period, 25 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', 11 'moderately sensitive', and 13 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly sensitive' taxa; one 'moderately sensitive' taxon [elmid beetles]; and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges]. Seven of the historically characteristic taxa were dominant in the spring 2014 community. These seven taxa comprised two 'moderately sensitive' and five 'tolerant' taxa; whereas five 'moderately sensitive'and five 'tolerant' taxa comprised the dominant taxa in the summer community. Five of the twelve taxa were dominant in both spring and summer communities (Table 19). Atypical increases in numerical abundances within four 'moderately sensitive' taxa in particular in summer were reflected in the slightly higher (by 0.4 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 42% to 84% 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 (90 units) is four units above the altitude prediction and three units lower than the predictive distance value, while the spring, 2014 survey score (92 units) was an insignificant (Stark, 1998) six units higher than the altitude predictive value and one unit lower than the distance predictive value. The summer, 2015 score (89 units) was midway between the predictive altitude and predictive distance values. Of the 40 surveys to date at this site, 40% of MCI scores have been less than 86 units while only 28% have been greater than 93 units.

#### 3.2.4.2.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = + 0.392
p level = 0.0004 [>FDR, p = 0.001]
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 relatively low scores between 2003 and 2008. However, the more recent scores remain well above those recorded over the first five years of the period. The LOWESS-smoothed scores have varied over an ecologically important 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 fifteen 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' to 'expected' where it has remained since 2000.

#### 3.2.4.3 Discussion

Seasonal MCI values decreased (by two units) between spring and summer at the mid- reach (SH3a) site where the historical median summer decrease has also been two units (Appendix II). A less typical decrease (of only three units) was found at the lower reach site where a larger historical median summer decrease of six units has been recorded (Appendix II). The percentage compositions of 'tolerant' taxa were higher (by 7% and 4%) in the summer mid and lower reach communities respectively. Seasonal communities at the mid-reach site (SH3a) shared 22 common taxa (65% of the 34 taxa found at this site in 2014-2015) compared with 18 shared common taxa (60% of the 30 taxa found in 2014-2015) at the lower reach site (Devon Road), a typically more dissimilar summer community structure at the lower reach site. The two sites shared 19 common taxa (58% of the 33 taxa) in spring and 19 common taxa (58% of 33 taxa) in summer, indicative of identical dissimilarity in spatial community structures in spring and summer.

MCI score typically decreased in a downstream direction in spring (by seven units) and in summer (by seven units), over a stream distance of 15.1 km downstream from the National Park boundary. These falls in MCI scores equated to average rates of decline of 0.5 unit/km in spring and in summer, identical to the predicted average 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 average rate of overall decline has been 0.4 MCI unit/km over the surveyed length. Therefore average rates of decline over the 2014-2015 period were slightly higher in spring and in summer than the median historical average 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 2014-2015 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

Twenty-four surveys have previously been undertaken at this upper reach site just inside the National Park boundary in the Waiwhakaiho River between November 2002 and February 2014. 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 together with spring 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WKH000100 | 24 | 4-29 | 19 | 115-147 | 129 | 22 | 128 | 25 | 130 |

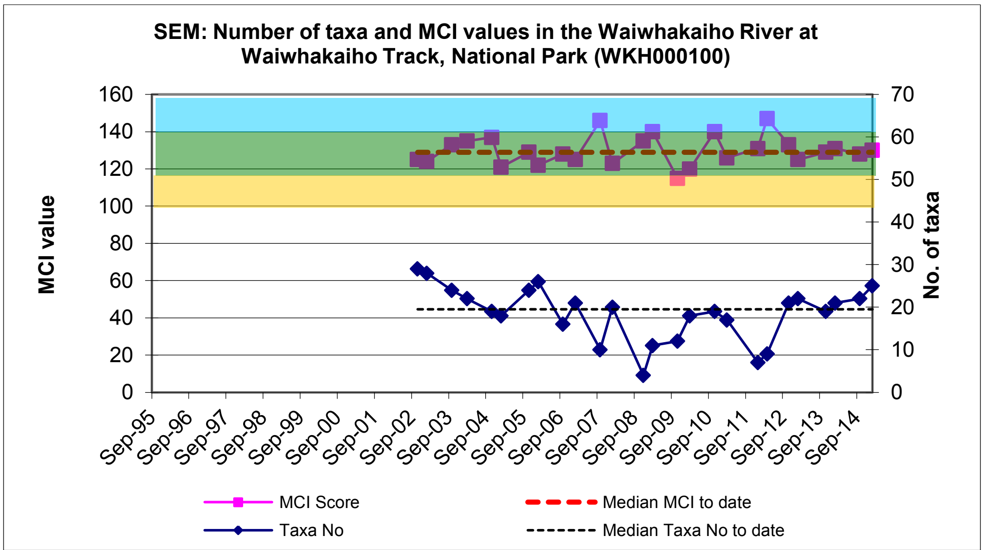



**Figure 16** Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont National Park

A wide range of richnesses (4 to 29 taxa) has been found, wider than might be expected due to headwater erosion effects over the 2008-2009 period with a median richness of 19 taxa, much lower than typical richnesses [eg median of 28 taxa and maximum of 40 taxa] in ringplain streams and rivers near the National Park boundary (TRC, 2015a). During the 2014-2015 period spring (22 taxa) and summer (25 taxa) richnesses were higher than this median richness following more recent post-headwater erosion recovery, with minimal evidence of siltation remaining at this site. The iron-oxide sedimentation and discolouration from a headwater tributary, which had occurred in early November 2013, was not as evident as iron oxide deposits on the boulders and sediment at this site as it had been in the previous period. There was some increase in turbidity (cloudiness) of the flow recorded in spring but this had cleared by the time of the summer survey.

MCI values have had a wider range (32 units) at this site than typical of a National Park boundary site, due in part to an atypically very high value in 2008 following a marked drop in richness and low values after the 2008-2009 headwater erosion period. The median value (129 units) has been slightly lower than typical of upper reach sites elsewhere on the ringplain (TRC, 2015a)). The spring, 2014 (128 units) and summer, 2015 (130 units) scores were within one unit of the historical median. They categorised this site as having 'very good' (spring and summer) health generically and, in terms of predictive relationships, 'expected' health for the upper reaches of a ringplain stream on both these occasions with taxa richnesses indicative of continued recovery post-headwater erosion and from the more recent brief iron-oxide headwater sedimentation event. The historical median score (129 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 2014-2015 period are listed in Table 21.

**Table 21** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at the National Park between 1995 and February 2014 [24 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **EPHEMEROPTERA** | *Coloburiscus* | 7 | 2 | 8 | | |
| | *Deleatidium* | 8 | 24 | 100 | XA | XA |
| | *Nesameletus* | 9 | 4 | 17 | A | A |
| **PLECOPTERA** | *Megaleptoperla* | 9 | 8 | 33 | A | |
| | *Zelandoperla* | 8 | 19 | 79 | VA | XA |
| **COLEOPTERA** | Elmidae | 6 | 22 | 92 | VA | XA |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 1 | 4 | | |
| | *Costachorema* | 7 | 2 | 8 | | |
| | *Hydrobiosella* | 9 | 1 | 4 | | |
| | *Beraeoptera* | 8 | 6 | 25 | VA | A |
| | *Olinga* | 9 | 0 | 0 | | A |
| **DIPTERA** | *Aphrophila* | 5 | 9 | 38 | A | A |
| | Eriopterini | 5 | 3 | 13 | | |
| | *Maoridiamesa* | 3 | 1 | 4 | | |
| | Orthocladiinae | 2 | 2 | 8 | | |

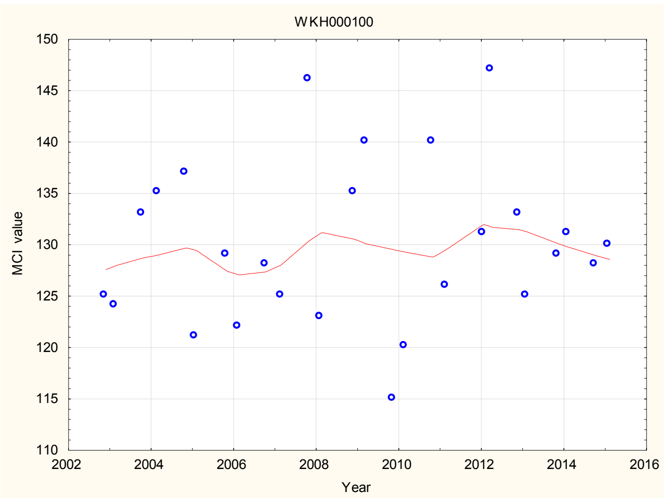
Prior to the current 2014-2015 period, 14 taxa had characterised the community at this site on occasions. These have comprised six 'highly sensitive', five 'moderately sensitive', and three 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected near the National Park boundary of a ringplain stream. However, there have been fewer numerically dominant taxa than are typical in the upper reaches of a ringplain stream. Predominant taxa have included two 'highly sensitive' taxa [mayfly (*Deleatidium* on every sampling occasion) and stonefly (*Zelandoperla*)]; one 'moderately sensitive' taxon [elmid beetles]; but no 'tolerant' taxa. Seven of these historically characteristic taxa were dominant in the spring 2014 community and six of these same taxa were again dominant in the summer 2015 community together with one 'highly sensitive' taxon [horn-cased caddisfly (*Olinga*)] not previously found in abundance at this site. No 'tolerant' taxa were dominant on either sampling occasion coincident with minimal periphyton substrate cover at this site. This represented some improvement in characteristic communities on both sampling occasions in comparison with more sparsely populated communities on occasions in the past. The relatively few taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 25% to 100% of past surveys.

#### 3.2.5.1.3 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 (129 units) is only two units lower than the altitude prediction and three units lower than the distance predictive value, with the spring, 2014 survey score (128 units) only three to four units lower than predictive values and the summer, 2015 score (130 units) within two units of both predictive values. Of the 26 surveys to date at this site, 58% of MCI scores have been less than 131 units while 35% have been greater than 132 units.

#### 3.2.5.1.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the 13 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 = 26
Kendall tau = +0.087
p level = 0.531 (>FDR, p = 0.617)
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 13 year monitoring period at this site within the National Park. Smoothed scores consistently have indicated 'very good' generic (Table 1) river health 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 as 'expected' while some individual scores indicative of 'worse than expected' health have followed headwater erosion events during the thirteen year period.

### 3.2.5.2 Egmont Village site (WKH000500)

#### 3.2.5.2.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Waiwhakaiho River at this mid-reach site at SH 3, Egmont Village (above the Mangorei Power Scheme) between October 1995 and February 2014. 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 together with spring 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | | Taxa no | MCI | Taxa no | MCI |
| WKH000500 | 38 | 14-32 | 23 | 87-122 | 110 | | 22 | 115 | 22 | 108 |

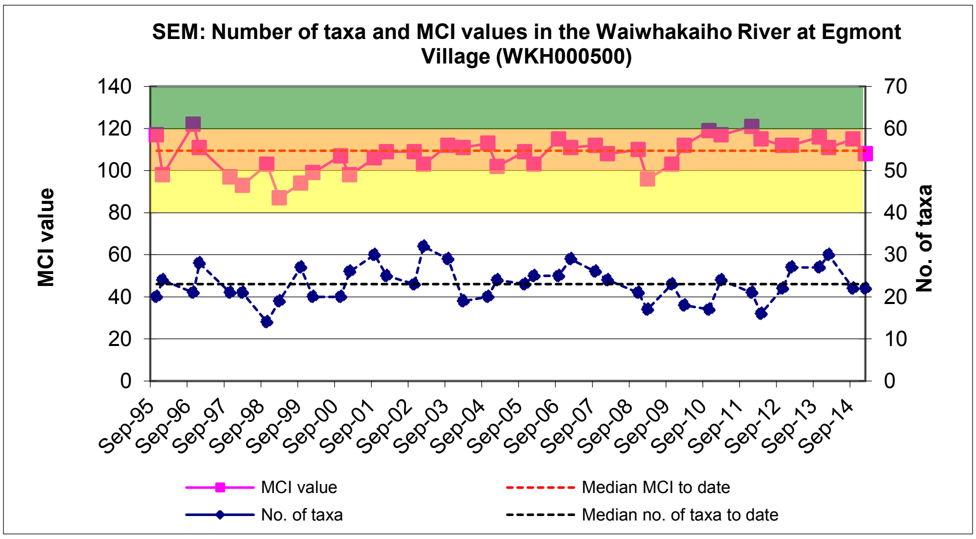



**Figure 18** Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont Village

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 (TRC, 2015a)). During the 2014-2015 period spring (22 taxa) and summer (22 taxa) richnesses were identical and very similar to the median taxa number to date.

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 (110 units) has been relatively typical of mid reach sites elsewhere on the ringplain however, with the spring, 2014 (115 units) and summer, 2015 (108 units) scores typical for such a site and from five units higher to two units lower than the historical median. These scores categorised this site as having 'good' (spring and summer) health generically and, in terms of predictive relationships 'better than expected' (spring) and 'expected' (summer) health for the mid reaches of a ringplain river. The historical median score (110 units) placed this site in the 'good' and '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 2014-2015 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 February 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMATODA** | Nematoda | 3 | 1 | 3 | | |
| **ANNELIDA** | Oligochaeta | 1 | 8 | 21 | | |
| **EPHEMEROPTERA** | *Coloburiscus* | 7 | 12 | 32 | VA | |
| | *Deleatidium* | 8 | 31 | 82 | XA | VA |
| | *Nesameletus* | 9 | 3 | 8 | | |
| **PLECOPTERA** | *Zelandoperla* | 8 | 2 | 5 | A | |
| **COLEOPTERA** | Elmidae | 6 | 24 | 63 | | VA |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 2 | 5 | | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 66 | A | VA |
| | *Costachorema* | 7 | 14 | 37 | VA | |
| | *Hydrobiosis* | 5 | 6 | 16 | | |
| | *Neurochorema* | 6 | 5 | 13 | | |
| | *Beraeoptera* | 8 | 1 | 3 | | |
| | *Oxyethira* | 2 | 8 | 21 | | |
| | *Pycnocentrodes* | 5 | 5 | 13 | | |
| **DIPTERA** | *Aphrophila* | 5 | 31 | 82 | A | A |
| | Eriopterini | 5 | 2 | 5 | | |
| | *Maoridiamesa* | 3 | 33 | 87 | VA | A |
| | Orthocladiinae | 2 | 35 | 92 | | A |
| | Tanytarsini | 3 | 10 | 26 | | |
| | Empididae | 3 | 2 | 5 | | |
| | Muscidae | 3 | 4 | 11 | | |
| | *Austrosimulium* | 3 | 1 | 3 | | |

Prior to the current 2014-2015 period, 23 taxa had characterised the community at this site on occasions. These have comprised four 'highly sensitive', nine 'moderately sensitive', and ten 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and in comparison with the National Park site, a (downstream) increase in 'tolerant' taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [elmid beetles and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [free-living caddisfly (*Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)]. Seven and six of the historically characteristic taxa were dominant in the spring, 2014 and summer 2014 communities respectively. These comprised two 'highly sensitive', three ‘moderately sensitive’, and two ‘tolerant’ taxa in spring and one ‘highly sensitive’, two ‘moderately sensitive’, and three ‘tolerant’ taxa in summer. Four of these nine taxa were dominant in both spring and summer communities (Table 23). Some decrease in abundance in the predominant taxon [mayfly (*Deleatidium*)] and decreased abundances within three other ‘sensitive’ taxa in summer resulted in a decrease of 1.4 $SQMCI_S$ units in summer (Tables 134 and 135).

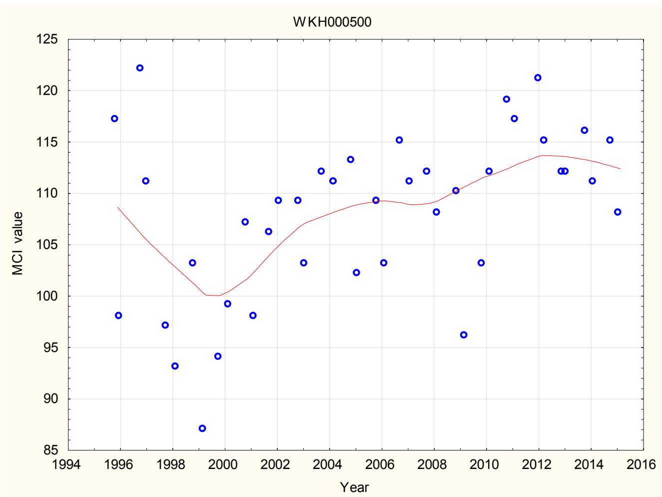
Of the predominant taxa in the 2014-2015 period, the ‘highly sensitive’ mayfly (*Deleatidium*), ‘moderately sensitive’ mayfly (*Coloburiscus*), elmid beetles, and caddisfly (*Costachorema*), and ‘tolerant’ caddisfly (*Hydropsyche-Aoteapsyche*) and midge (*Maoridiamesa*), have characterised this site’s communities on 32% to 87% of survey occasions to date.

#### 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 (110) is eight units higher than the altitude prediction and five units higher than the distance predictive value while the spring, 2014 (115 units) and summer 2015 (108 units) scores were higher than both predictive values, by three to a significant 13 units. Of the 40 surveys to date at this site, only 15% of MCI scores have been less than 102 units while 68% have been greater than 105 units.

#### 3.2.5.2.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.344
p level = 0.002 [>FDR, p = 0.004]
Significant at $p < 0.05$ and $p < 0.01$ after FDR application

**Figure 19** LOWESS trend plot at the Egmont Village site

An overall significant trend in MCI scores has been found during the 20 year period. After some initial deterioration in scores, there has been a steady improvement since 1999. The variability in the LOWESS-smoothed range (14 MCI units) has been of ecological importance over the period. While the individual scores were indicative of 'good' to 'fair' generic river health (Table 1) over the first five years, smoothed scores indicated that 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 'expected' for most of the period, improving toward 'better than expected' more recently.

### 3.2.5.3 Constance Street site (WKH000920)

#### 3.2.5.3.1 Taxa richness and MCI

Thirty-nine surveys have been undertaken in the Waiwhakaiho River at this lower reach site at Constance Street, New Plymouth (below the Mangorei Power Scheme) between 1995 and February 2014. 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, together with spring 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WKH000920 | 39 | 12-29 | 20 | 71-110 | 95 | 19 | 88 | 16 | 79 |

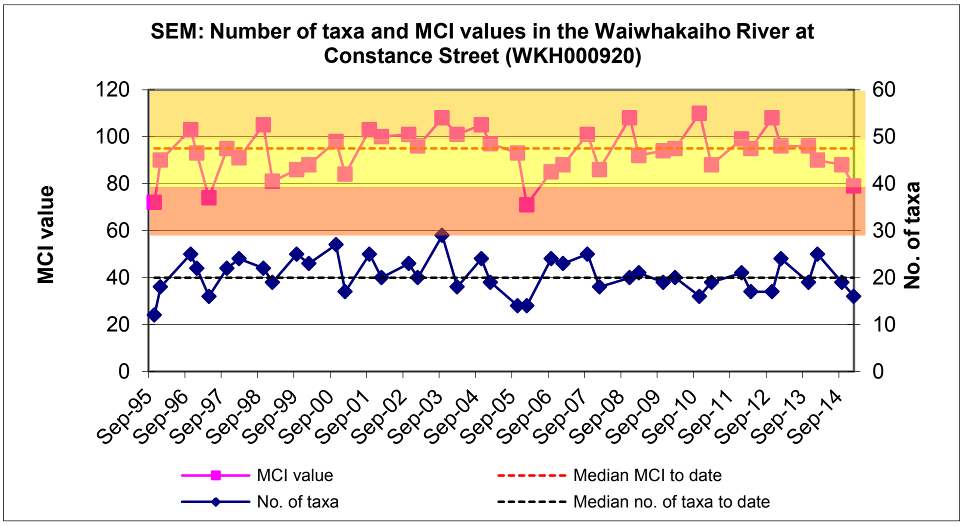



**Figure 20** Numbers of taxa and MCI values in the Waiwhakaiho River at Constance Street

A wide range of richnesses (12 to 29 taxa) has been found with a median richness of 20 taxa (more representative of typical richnesses in the lower reaches of ringplain streams and rivers (TRC, 2015a)). During the 2014-2015 period, spring (19 taxa) and summer (16 taxa) richnesses were relatively similar but from one to four taxa lower than the median richness on these occasions.

MCI values have had a wide range (39 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (95 units) has been relatively typical of scores at lower reach sites elsewhere on the ringplain, however (TRC, 2015a). The spring, 2014 (88 units) and summer, 2015 (79 units) scores were different although relatively typical of scores for such a site. They were seven units below the historical median in spring and significantly lower than the median (by 16 units) in summer. These scores categorised this site as having 'fair' (spring) and 'poor' (summer) health generically (Table 1) and in terms of predictive relationships (Table 2) 'expected' health in spring and 'worse than expected' in summer for the lower reaches of a ringplain river. The historical median score (95 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

#### 3.2.5.3.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 February 2014 [39 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 1 | 3 | | |
| ANNELIDA | Oligochaeta | 1 | 23 | 59 | A | |
| MOLLUSCA | *Potamopyrgus* | 4 | 3 | 8 | | A |
| CRUSTACEA | *Paratya* | 3 | 1 | 3 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 1 | 3 | | |
| | *Coloburiscus* | 7 | 5 | 13 | | |
| | *Deleatidium* | 8 | 21 | 54 | A | |
| COLEOPTERA | Elmidae | 6 | 11 | 28 | | A |
| | Staphylinidae | 5 | 1 | 3 | | |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 31 | 79 | | A |
| | *Costachorema* | 7 | 6 | 15 | | |
| | *Hydrobiosis* | 5 | 8 | 21 | | |
| | *Neurochorema* | 6 | 1 | 3 | | |
| | *Oxyethira* | 2 | 12 | 31 | | |
| DIPTERA | *Aphrophila* | 5 | 8 | 21 | | |
| | *Maoridiamesa* | 3 | 19 | 49 | A | |
| | Orthocladiinae | 2 | 38 | 97 | A | A |
| | Tanytarsini | 3 | 17 | 44 | | A |
| | Muscidae | 3 | 3 | 8 | | |
| | *Austrosimulium* | 3 | 4 | 10 | | |

Prior to the current 2014-2015 period, 20 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', eight 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa with a downstream increased proportion of 'tolerant' taxa (compared to the characteristic taxa in the upper and mid-reaches) as would be expected in the lower reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxa [ubiquitous mayfly (*Deleatidium*)]; no 'moderately sensitive' taxa; but three 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges]. Only four of the historically characteristic taxa were dominant in the spring 2014 community. These comprised one 'highly sensitive' taxon and three 'tolerant' taxa, whereas no 'highly sensitive, one 'moderately sensitive', and four 'tolerant' taxa comprised the dominant taxa of the summer, 2015 community. Only one of these eight taxa was dominant in both spring and summer communities (Table 25). Despite these dissimilarities in seasonal dominances there was a minimal decrease of 0.2 unit between spring and summer summer $SQMCI_s$ scores mainly due to the predominance of 'tolerant' taxa in both seasons' communities (Tables 134 and 135).

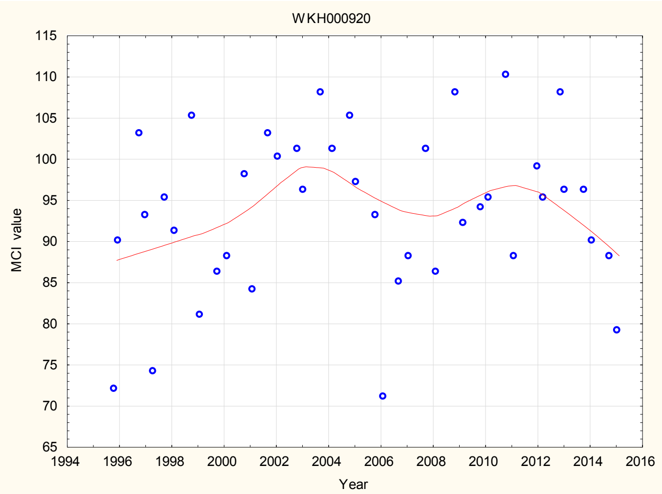
Those taxa dominant in spring and/or summer surveys (although not very/extremely abundant), had characterised this site's communities on 28% to 97% of past survey occasions.

#### 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 (95) is 9 units higher than the altitude prediction and equal with the distance predictive value. The spring, 2014 survey score (88 units) was insignificantly two units higher than the altitude and seven units lower than the distance predictive values while the summer 2015 score (79 units) was seven units lower than the predictive altitude value and a significant (Stark, 1998) 16 units below the predicted distance value. Of the 41 surveys to date at this site, 17% of MCI scores have been less than 86 units while 41% have been greater than 95 units.

#### 3.2.5.3.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 41
Kendall tau = +0.073
p level = 0.501 [> FDR, p = 0.617]
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 scores after 2005 and again since 2012. The LOWESS-smoothed range of scores (11 units) indicates variability of some ecological importance. Smoothed MCI scores indicated 'fair' generic river health (Table 1) improving toward 'good' health (after a small increase in summer residual flow releases by the TrustPower Mangorei HEP scheme) before returning to 'fair' health over recent years. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, river health improved from 'expected' early in the period toward 'better than expected' for a brief period (2003-2004) before returning to 'expected'health.

### 3.2.5.4 Site adjacent to Lake Rotomanu (WKH000950)

#### 3.2.5.4.1 Taxa richness and MCI

Thirty-seven surveys have been undertaken in the Waiwhakaiho River at this lower reach site adjacent to Lake Rotomanu between March 1997 and February 2014. 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 site adjacent to Lake Rotomanu, together with spring 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WKH000950 | 37 | 12-30 | 21 | 70-111 | 88 | 23 | 94 | 15 | 75 |

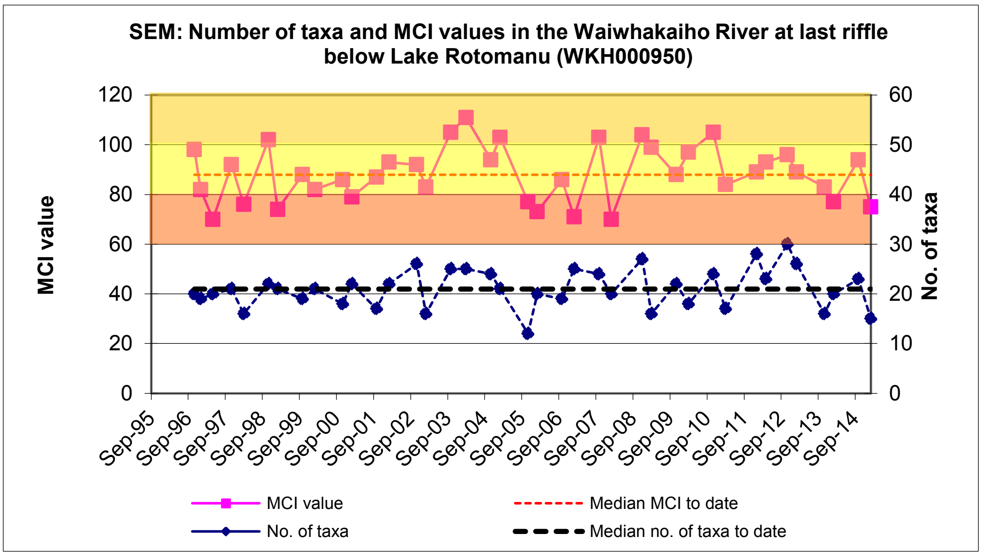



**Figure 22** Numbers of taxa and MCI values in the Waiwhakaiho River at Lake Rotomanu

A wide range of richnesses (12 to 28 taxa) has been found; wider than might be expected, with a median richness of 21 taxa. During the 2014-2015 period spring (23 taxa) richness was eight taxa more than found later in summer. Spring richness was two taxa higher than the median richness whereas sumer richness was six taxa fewer than the historical median and only three taxa above the historical minimum.

MCI values have had a wide range (41 units) at this site but typical of variable scores at sites in the lower reaches of ringplain streams. The median value (88 units) has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 2015a). The spring 2014 (94 units) and summer, 2015 (75 units) scores, although typical for such a site, were a significant 13 units lower (in summer) but six units higher in spring than the historical median. These scores categorised this site as having 'fair' (spring) and 'poor' (summer) health generically (Table 1) and in terms of predictive relationships (Table 2) 'expected' health in spring and 'worse than expected' 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 2014-2015 period are listed in Table 27.

**Table 27** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiwhakaiho River at the site adjacent to Lake Rotomanu between 1995 and February 2014 [37 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 3 | 8 | | |
| **ANNELIDA** | Oligochaeta | 1 | 31 | 84 | VA | A |
| **MOLLUSCA** | *Physa* | 3 | 1 | 3 | | |
| | *Potamopyrgus* | 4 | 13 | 35 | A | XA |
| **CRUSTACEA** | *Paratya* | 3 | 8 | 22 | | |
| **EPHEMEROPTERA** | *Coloburiscus* | 7 | 1 | 3 | | |
| | *Deleatidium* | 8 | 10 | 27 | | |
| **COLEOPTERA** | Elmidae | 6 | 8 | 22 | | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 26 | 70 | | A |
| | *Costachorema* | 7 | 2 | 5 | | |
| | *Hydrobiosis* | 5 | 3 | 8 | | |
| | *Oxyethira* | 2 | 15 | 41 | | |
| **DIPTERA** | *Aphrophila* | 5 | 13 | 35 | | |
| | *Maoridiamesa* | 3 | 18 | 49 | VA | |
| | Orthocladiinae | 2 | 37 | 100 | XA | VA |
| | Tanytarsini | 3 | 15 | 41 | | A |
| | Empididae | 3 | 1 | 3 | | |
| | Muscidae | 3 | 1 | 3 | | |
| | *Austrosimulium* | 3 | 1 | 3 | | |

Prior to the current 2014-2015 period, 19 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', five 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a minority of 'sensitive' taxa and a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included no 'highly sensitive' or 'moderately sensitive' taxa; but three 'tolerant' taxa (oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges). Four of the historically characteristic taxa were dominant in the spring, 2014 community. These were all comprised of 'tolerant' taxa. No 'highly sensitive', or 'moderately sensitive', but five 'tolerant' taxa comprised the dominant taxa of the summer, 2015 community. Three of these six taxa were dominant in both spring and summer communities (Table 27). The $SQMCI_s$ scores increased between spring and summer by 2.2 units (Tables 134 and 135) principally as a result of subtle changes in numerical dominance from the 'extremely tolerant' oligochaete worms and 'very tolerant' orthoclad midges in spring to the 'tolerant' snail in summer.

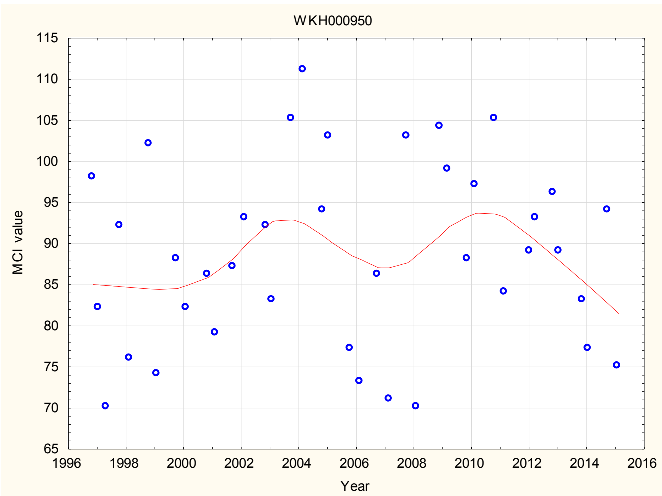
The most abundant 'tolerant' oligochaete worms, snail (*Potamopyrgus*), and midges (orthoclads and *Maoridiamesa*) have characterised this site's communities on 35% to 100% of past survey occasions.

#### 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 three units higher than the altitude prediction and six units lower than the distance predictive value. The spring 2014 survey score (94 units) was from nine units higher to equal with these predictive values while the summer score (75 units) was ten units less than the predictive altitude and a significant 19 units below the distance values. Of the 39 surveys to date at this site, 36% of MCI scores have been less than 85 units while 26% have been greater than 94 units.

#### 3.2.5.4.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 39
Kendall tau = +0.064
p level = 0.567 [> FDR, p = 0.640]
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 another improvement and subsequent decline, relatively similar trends to those found at the nearest upstream site (Constance St). The LOWESS-smoothed range of scores (12 units) is of marginal ecological importance with slightly more marked variability over the 2007 to 2015 period. Smoothed MCI scores have indicated 'fair' generic stream 'health' (Table 1) throughout the period. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain river, health has remained in the 'expected' category over the entire period.

#### 3.2.5.5 Discussion

Seasonal MCI values typically decreased between spring and summer at three sites from the mid to lower reaches by seven, nine, and 19 units respectively in a downstream direction whereas scores at the upper-catchment increased (but only by two units) in summer. Seasonal communities shared 57% of a total of 30 taxa present at the upper site, 63% of 27 taxa at the mid reach site, and in the lower reaches, 40% of 25 taxa at the Constance Street site, and 52% of 25 taxa at the furthest downstream site. The typical decrease in seasonal faunal similarities in a downstream direction, as might be anticipated given wider variability in seasonal substrate periphyton cover and water temperature in the lower reaches, was more apparent between seasons in the 2014-2015 period particularly at the lower sites.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 34 units in spring and 55 units in summer, over a river distance of 28.7 km. These seasonal falls in MCI scores equated to average rates of decline of 1.2 units/km (spring) and 1.9 units/km (summer), compared with a predicted average rate of 1.3 units/km for the equivalent length and reach of a National Park-sourced river (Stark and Fowles, 2009). This was typical of the trend of past summer seasonal average rates of decline which have usually been higher (with the 2012-2013 period an exception).

Between the upper and mid-reach sites, the spring (0.7 unit/km) and summer (2.1 units/km) average rates of decline were far lower in spring and lower in summer than the predicted average rate (2.6 units/km) for the equivalent river reach. For the mid-reach to lower reach sites, spring (1.2 units/km) and summer (1.9 units/km) average rates of decline were well above the predicted average rate of 0.6 unit/km, particularly in summer.

Using the long-term median SEM MCI scores for each site (Appendix II) the average rates of decline between upper and mid catchment and between mid catchment and lower river sites have been about 1.8 and 1.2 units per km respectively with an overall average rate of decline of 1.4 MCI units/km over the river's length. Therefore overall seasonal average rates of decline over the 2014-2015 period were between 0.2 unit/km lower and 0.5 unit/km higher than the historical average rate, but in the mid to lower reaches, spring and summer MCI average rates of decline were equal with to 0.7 unit/km above the corresponding historical average rate.

Community composition varied markedly through the length of the river surveyed. A total of 41 taxa was recorded in spring of which only eight taxa were present at all four sites. These included one 'highly sensitive', four 'moderately sensitive', and three 'tolerant' taxa with no taxa abundant at all four sites. One 'highly sensitive' taxon was abundant at three sites and one 'tolerant' taxon was abundant at three sites (mid and lower reaches of the river). A very slightly higher total of 42 taxa was found along the river's length by the summer survey of which only four taxa were present at all four sites. Two of these were also amongst the widespread taxa in spring with the loss of one 'highly sensitive', one 'moderately sensitive', and two 'tolerant' taxa. Again no taxon was abundant at all four sites. These dissimilarities in seasonal spatial community structures along the length of the Waiwhakaiho River were more pronounced in summer as typically has been found previously.

## 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 2014-2015 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

Twenty-four surveys have been undertaken at this lower reach site in the Mangorei Stream between November 2002 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MGE000970 | 24 | 22-33 | 29 | 86-113 | 102 | 27 | 94 | 23 | 94 |

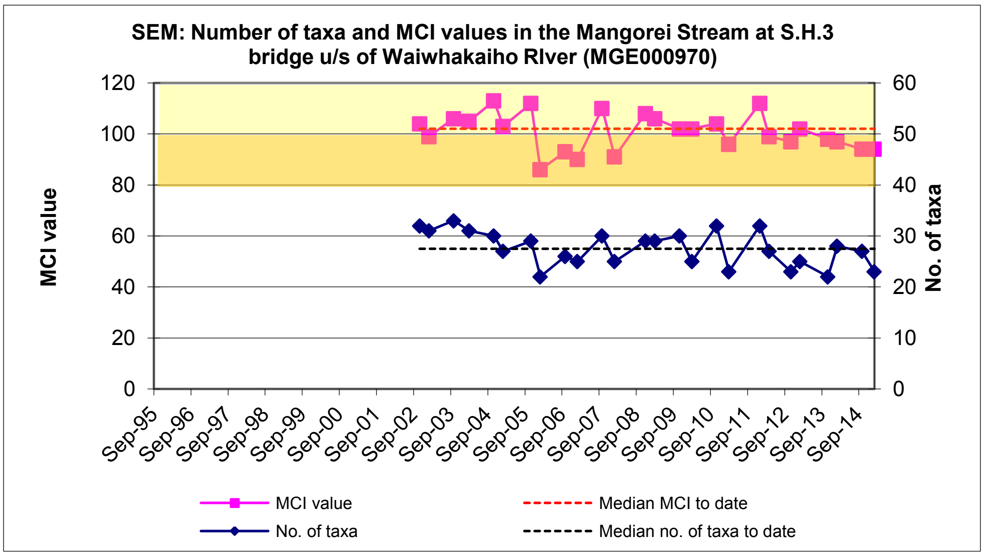



**Figure 24** Numbers of taxa and MCI values in the Mangorei Stream at SH3

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 (TRC, 2015a)]. During the 2014-2015 period, spring (27 taxa) richness was near this median richness and six taxa fewer 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 (103 units) has been more typical of mid-reach sites elsewhere on the ringplain, although the spring, 2014 (94 units) and summer, 2015 (94 units) scores were lower but within eight units of the historical median. These scores categorised this site as having 'fair' health (spring and summer) generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health (spring and summer) for this site in the lower reaches. The historical median score (102 units) placed this site in the 'good' and '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 2014-2015 period are listed in Table 29.

**Table 29** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Mangorei Stream at SH3 between 2002 and February 2014 [24 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 2 | 8 | | |
| ANNELIDA | Oligochaeta | 1 | 15 | 63 | A | |
| MOLLUSCA | *Potamopyrgus* | 4 | 7 | 29 | A | A |
| EPHEMEROPTERA | *Austroclima* | 7 | 15 | 63 | | |
| | *Coloburiscus* | 7 | 11 | 46 | | |
| | *Deleatidium* | 8 | 16 | 67 | A | |
| PLECOPTERA | *Zelandobius* | 5 | 8 | 33 | VA | |
| | *Zelandoperla* | 8 | 2 | 8 | | |
| COLEOPTERA | Elmidae | 6 | 16 | 67 | A | A |
| MEGALOPTERA | *Archichauliodes* | 7 | 17 | 71 | A | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 22 | 92 | A | |
| | *Costachorema* | 7 | 3 | 13 | | |
| | *Hydrobiosis* | 5 | 12 | 50 | | |
| | *Neurochorema* | 6 | 5 | 21 | | |
| | *Confluens* | 5 | 3 | 13 | | |
| | *Oxyethira* | 2 | 9 | 38 | | A |
| | *Pycnocentrodes* | 5 | 6 | 25 | | |
| DIPTERA | *Aphrophila* | 5 | 19 | 79 | A | |
| | *Maoridiamesa* | 3 | 11 | 46 | | |
| | Orthocladiinae | 2 | 23 | 96 | A | A |
| | Tanytarsini | 3 | 15 | 63 | A | |
| | Empididae | 3 | 4 | 17 | A | A |
| | Muscidae | 3 | 1 | 4 | | |
| | *Austrosimulium* | 3 | 19 | 79 | A | A |

Prior to the current 2014-2015 period, 24 taxa have characterised the community at this site on occasions. These have comprised two 'highly sensitive', eleven 'moderately sensitive', and eleven 'tolerant' taxa i.e. an increased proportion of 'tolerant' taxa as would be expected toward the lower reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; six 'moderately sensitive' taxa [mayflies (*Austroclima* and *Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*), and cranefly

(*Aphrophila*)]; and five 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), midges (orthoclads and tanytarsids), and sandfly (*Austrosimulium*)].

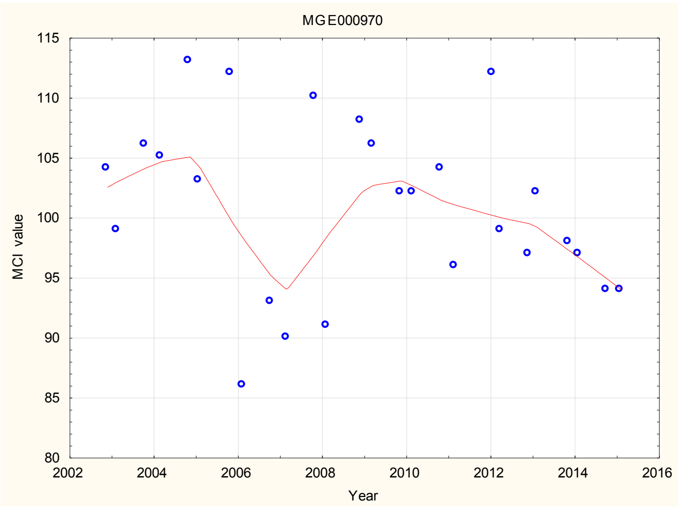
Nine of these predominant taxa were dominant in the spring, 2014 community together with three of the other historically characteristic taxa. The summer, 2015 community was characterised by fewer (six) of the taxa dominant in spring, together with an additional one 'tolerant' taxon and three fewer 'sensitive' taxa and three fewer 'tolerant' taxa (Table 29). In particular, the reduction in numerical abundances of the 'highly sensitive' mayfly and 'moderately sensitive' stonefly were reflected by the small 0.4 unit decrease in $SQMCI_s$ score recorded by the summer survey (Tables 136 and 137). The only taxon recorded as very/extremely abundant during spring and/or summer had characterised this site's communities on 33% of past survey occasions.

### 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 (102 units) is eight units higher than the altitude prediction and one unit above the distance predictive value. The spring 2014 and summer 2015 scores (94 units) were equal with the predictive value for altitude and seven units lower than the predictive value for distance. Of the 26 surveys to date at this site, 15% of MCI scores have been less than 94 units while 54% have been greater than 101 units.

### 3.2.6.1.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the thirteen years (2002-2015) 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 = 26
Kendall tau = - 0.250
p level = 0.073 [>FDR, p = 0.122]
N/S at $p < 0.05$

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

While smoothed MCI scores showed slight initial improvement over the first three years, followed by a steady decline, between 2005 and 2011 there had been further improvement in scores towards those recorded earlier in the programme, followed by a steady decline since 2010. The overall decline over the thirteen year period has not been a statistically significant trend at this site. The LOWESS-smoothed range of scores (11 units) has been indicative of marginal ecological importance in variability. During the period, these smoothed MCI scores have been consistently indicative of 'good' generic stream health (Table 1) with some deterioration to 'fair' health between 2006 and 2008 prior to some recovery, followed by a more recent decline to 'fair' health since 2013. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, stream health has been in the 'expected' category almost throughout the thirteen year period, bordering on 'better than expected' for a short period in 2004-2005, coincident with good riparian vegetation cover at this site.

#### 3.2.6.2 Discussion

Seasonal MCI values atypically did not change between spring and summer at this lower reach (SH3) site where (more typically) the historical median summer decrease has been five units (Appendix II). This was coincident with a small percentage increase in the composition of 'tolerant' taxa (7%) in the summer community under slightly more patchy periphyton substrate cover conditions. Spring and summer communities at this site shared 20 common taxa (67% of the 30 taxa found in 2014-2015), a relatively high percentage of common taxa for these two seasonal surveys at this site.

## 3.2.7 Manganui River

The results found by the 2013-2014 surveys are presented in Tables 138 and 139, Appendix I.

### 3.2.7.1 State Highway 3 site (MGN000195)

#### 3.2.7.1.1 Taxa richness and MCI

Forty surveys have been undertaken at this mid reach site in the Manganui River between September 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Dec 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MGN000195 | 40 | 12-26 | 21 | 113-143 | 126 | 23 | 129 | 22 | 123 |

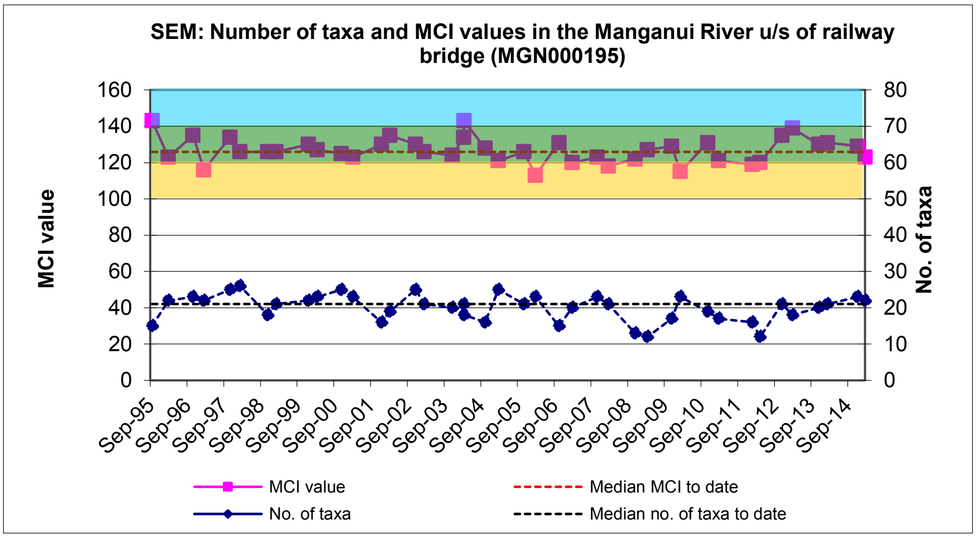



**Figure 26** Numbers of taxa and MCI values in the Manganui River above the railway bridge (SH3)

A wide range of richnesses (12 to 26 taxa) has been found, with a median richness of 21 taxa (slightly lower than typical richnesses in the mid-reaches of ringplain streams and rivers). During the 2014-2015 period richnesses were very similar in spring (23 taxa) and summer (22 taxa) and were within two taxa of this median richness.

MCI values have had a relatively wide range (30 units) at this site, slightly wider than typical for a site in the mid reaches of a ringplain stream. The median value (126 units) was higher than has been typical of similar mid-reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (129 units) and summer, 2015 (123 units) scores were insignificantly three units higher and three units lower respectively than the historical median. These scores categorised this site as having 'very good' health generically (Table 1) in spring and in summer and, in terms of predictive relationships (Table 2), 'better than expected' health in spring and 'expected' health in summer for this site in the mid reaches of a ringplain river. The historical median score (126 units) placed this site in the 'very good' and 'better than 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 2014-2015 period are listed in Table 31.

**Table 31** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Manganui River at SH3 between 1995 and February 2014 [39 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 3 | 8 | | A |
| | *Coloburiscus* | 7 | 28 | 70 | VA | A |
| | *Deleatidium* | 8 | 39 | 98 | XA | XA |
| | *Nesameletus* | 9 | 27 | 68 | VA | VA |
| **PLECOPTERA** | *Acroperla* | 5 | 1 | 3 | | |
| | *Megaleptoperla* | 9 | 1 | 3 | | |
| | *Zelandoperla* | 8 | 12 | 30 | A | |
| **COLEOPTERA** | Elmidae | 6 | 37 | 93 | VA | VA |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 4 | 10 | | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 16 | 40 | | A |
| | *Hydrobiosis* | 5 | 1 | 3 | | |
| | *Beraeoptera* | 8 | 9 | 23 | VA | A |
| | *Pycnocentrodes* | 5 | 2 | 5 | VA | A |
| **DIPTERA** | *Aphrophila* | 5 | 22 | 55 | | A |
| | Eriopterini | 5 | 3 | 8 | | |
| | *Austrosimulium* | 3 | 1 | 3 | | |

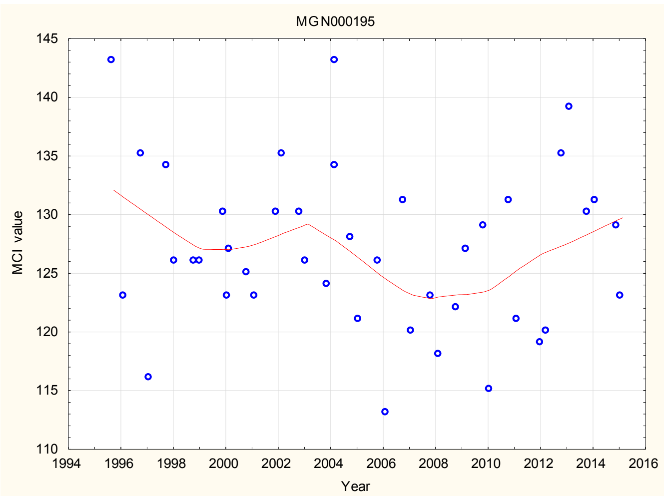
Prior to the current 2014-2015 period, 16 taxa have characterised the community at this site on occasions. These have comprised five 'highly sensitive', nine 'moderately sensitive', and two 'tolerant' taxa i.e. a higher proportion of 'sensitive' taxa than might be expected in the mid-reaches of a ringplain stream. Predominant taxa have included two 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*)] and three 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, and cranefly (*Aphrophila*)]; but no 'tolerant' taxa. Four of these predominant taxa were dominant in the spring, 2014 community together with two of the other historically characteristic 'highly sensitive' taxa and one 'moderately sensitive' taxon. The summer, 2015 community was characterised by six of the same taxa dominant in spring, together with two additional 'moderately sensitive' and one 'tolerant' taxa, which previously had been characteristic of this site's communities and one fewer 'highly sensitive' taxon (Table 31). Despite some decreases in abundances within some 'sensitive' taxa in summer, seasonal $SQMCI_s$ values (7.5 and 7.6 units) were relatively similar (Tables 138 and 139). The six taxa recorded as extremely or very abundant during spring and/or summer had characterised this site's communities on 5% to 98% of past survey occasions.

### 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 seven units higher than the altitude prediction and a significant (Stark, 1998) 19 units above the distance predictive value. The spring, 2014 survey score (129 units) was significantly higher by 11 to 22 units than both predictive values while the summer, 2015 score (123 units) was also higher (by five to a significant 16 units) than the predictive values. Of the 42 surveys to date at this site, no MCI scores have been less than 107 units while 90% have been greater than 118 units.

### 3.2.7.1.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 42
Kendall tau = - 0.080
p level = 0.458 [>FDR, p = 0.580]
Not significant at $p < 0.05$

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

A trend of very slight overall decrease in MCI scores was identified (more accentuated over the first twelve years) which however, has not been statistically significant for the twenty year period. The LOWESS-smoothed scores (range of 9 units) represented no ecological importance in terms of variability. These smoothed MCI scores consistently indicated 'very good' generic river health (Table 1) over the entire twenty year period. In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain stream, river health has been 'better than expected' throughout the twenty year period.

### 3.2.7.2 Bristol Road site (MGN000427)

#### 3.2.7.2.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken at this lower reach site at Bristol Road in the Manganui River between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Dec 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MGN000427 | 38 | 15-26 | 20 | 77-115 | 98 | 20 | 104 | 21 | 96 |

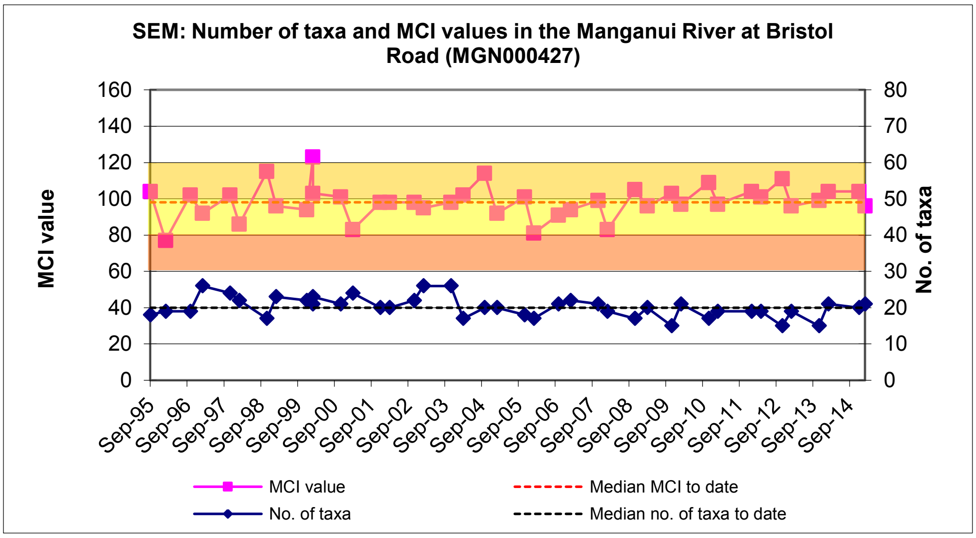



**Figure 28** Numbers of taxa and MCI values in the Manganui River at Bristol Road

A moderate range of richnesses (15 to 26 taxa) has been found with a median richness of 20 taxa which is representative of typical richnesses in ringplain streams and rivers in the lower reaches. During the 2014-2015 period, spring (20 taxa) and summer (21 taxa) richnesses were equal with the historical median richness in spring coincident with patchy substrate periphyton cover, and similar to median richness in summer, when periphyton substrate cover was just as patchy (although increased cyanobacterial cover was a component).

MCI scores have had a wide range (38 units) at this site, typical of sites in the lower reaches of streams elsewhere on the ringplain although this site was located at an atypically higher altitude of 140 m asl for a lower reach site more than 37 km downstream from the National Park boundary. The median value (98 units) has been higher than typical of lower reach ringplain sites (TRC, 2015a). The spring 2014 score (104 units) was six units higher than the historical median while the lower summer score (96 units) was two units lower 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), 'expected' (spring and 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 '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 2014-2015 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 2014 [36 surveys], and by the spring 2014 and summer 2015

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 2 | 5 | | |
| ANNELIDA | Oligochaeta | 1 | 17 | 45 | A | |
| MOLLUSCA | *Potamopyrgus* | 4 | 0 | | | A |
| EPHEMEROPTERA | *Coloburiscus* | 7 | 7 | 18 | | |
| | *Deleatidium* | 8 | 22 | 58 | VA | |
| COLEOPTERA | Elmidae | 6 | 14 | 37 | A | VA |
| MEGALOPTERA | *Archichauliodes* | 7 | 2 | 5 | | |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 27 | 71 | VA | VA |
| | *Costachorema* | 7 | 6 | 16 | A | |
| | *Hydrobiosis* | 5 | 12 | 32 | | A |
| | *Neurochorema* | 6 | 2 | 5 | | |
| | *Oxyethira* | 2 | 7 | 18 | | |
| DIPTERA | *Aphrophila* | 5 | 18 | 47 | A | |
| | *Maoridiamesa* | 3 | 17 | 45 | VA | |
| | Orthocladiinae | 2 | 37 | 97 | A | XA |
| | Tanytarsini | 3 | 11 | 29 | | A |
| | Empididae | 3 | 2 | 5 | | |
| | Muscidae | 3 | 6 | 16 | | |
| | *Austrosimulium* | 3 | 7 | 18 | | |

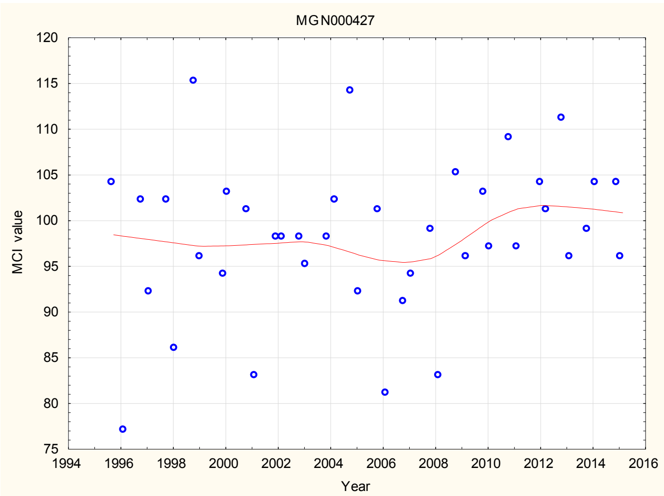
Prior to the current 2014-2015 period 18 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', seven 'moderately sensitive', and ten 'tolerant' taxa i.e. a majority of 'tolerant' taxa but a slightly higher proportion of 'sensitive' taxa than might be expected in the lower reaches of a ringplain river coincidental with this site's relatively high elevation above sea level. Predominant taxa have included one 'highly sensitive' taxon, no 'moderately' sensitive' taxa, and two 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and orthoclad midges]. Eight of the historically characteristic taxa were dominant in the spring, 2014 community. These comprised one 'highly sensitive', three 'moderately sensitive', and four 'tolerant' taxa, whereas only three of the same taxa together with an additional one 'moderately sensitive' and two 'tolerant' taxa (one of which ('tolerant' snail, *Potamopyrgus* ) had not previously been a characteristic taxon at this site), and one fewer 'highly sensitive', two fewer 'moderately sensitive', and two fewer 'tolerant' taxa comprised the dominant taxa in the summer, 2015 community. Three taxa were dominant in both spring and summer communities (Table 33). The difference of 1.8 units in $SQMCI_s$ scores recorded between seasons (Tables 138 and 139) was due principally to a reduction in abundance of the mayfly, *Deleatidium* in summer and marked increase in abundance of one 'tolerant' midge taxon . Those five taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 37% to 97% 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 between 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 prediction and seven units higher than the predictive distance value, while the spring, 2014 survey score (104 units) was insignificantly higher than the predictive altitude value and significantly higher than the predictive distance value. The summer score (106 units) was within fiveunits of these predictive values. Of the 40 surveys to date at this site, only 13% of MCI scores have been less than 91 units while 40% have been greater than 99 units.

#### 3.2.7.2.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 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 29.




N = 40
Kendall tau = +0.133
p level = 0.226 [>FDR, p = 0.309]
N/S at $p < 0.05$

**Figure 29** LOWESS trend plot at the Bristol Road site

The slight overall positive trend in MCI scores was not statistically significant. Neither has the ecological variability in LOWESS-smoothed scores of seven units been of ecological importance. The smoothed MCI scores were indicative of 'fair' generic river health at this site almost throughout the twenty year period improving to 'good' over the last few years. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain river, 'health' has remained in the 'expected' category throughout the period.

#### 3.2.7.3 Discussion

Seasonal MCI values typically decreased (by six units) between spring and summer at the mid-reach (SH3) site where historical seasonal median scores have decreased in summer by seven units (Appendix II). A further typical decrease (eight units) was recorded at the lower reach site where the historical median summer score has been six units lower over the twenty year period (Appendix II). The percentage composition of 'tolerant' taxa increased in the summer community at the mid reach site but only by 6%, whereas it more typically decreased by 17% at the lower reach site in summer. Seasonal communities at the mid-reach site (SH3) shared 17 common taxa (61% of the 28 taxa found at this site in 2014-2015) compared with 14 shared common taxa (52% of the 27 taxa found in 2014-2015) at the lower reach site (Bristol Road), a more pronounced seasonal change in community structure at the lower reach site. The two sites shared 13 common taxa (43% of the 30 taxa) in spring and 13 common taxa (43% of 30 taxa) in summer, indicative of the equivalent dissimilarity in spatial community structures in both spring and summer.

MCI score typically fell in a downstream direction in both spring (by 25 units) and typically slightly more so in summer (by 27 units), over a stream distance of 29.2 km downstream from the National Park boundary. These falls in MCI scores equated to average rates of decline of 0.85 unit/km in spring increasing slightly to 0.9 unit/km in summer, compared with a predicted average 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 average rate of decline between mid catchment and lower river sites has been about 1.0 MCI unit/km over the surveyed length. Therefore average rates of decline over the 2014-2015 period were slightly lower in spring and summer than the average historical median rate.

## 3.2.8 Maketawa Stream

Two sites, originally surveyed as components of the Maketawa catchment baseline investigation (Stark, 2003), were included in the 2002-03 SEM programme in recognition of the fisheries significance of this sub-catchment of the Manganui River catchment. The results from the surveys performed in the 2014-2015 monitoring year are presented in Table 140 and 141, Appendix I.

### 3.2.8.1 Derby Road site (MKW000200)

#### 3.2.8.1.1 Taxa richness and MCI

Twenty-nine surveys have been undertaken at this upper reach site in the Maketawa Stream between March 1998 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Dec 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MKW000200 | 29 | 8-33 | 23 | 100-141 | 128 | 31 | 130 | 26 | 126 |

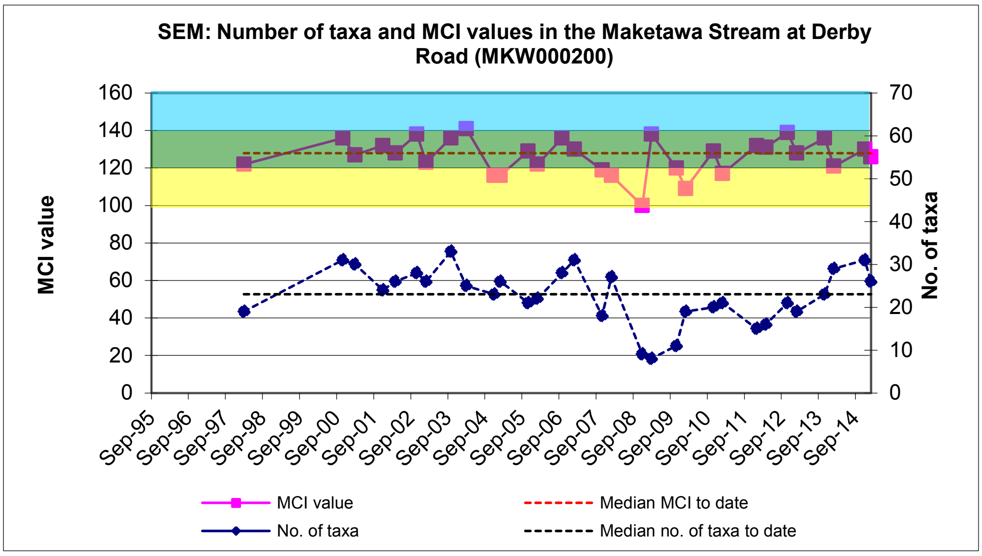



**Figure 30** Number of taxa and MCI values in the Maketawa Stream at Derby Road

A very wide range of richnesses (8 to 33 taxa) has been found as a result of marked reductions in richness due to the impacts of previous headwater erosion events, with a median richness of 23 taxa (slightly lower than typical richnesses found in the upper reaches of ringplain streams and rivers). During the 2014-2015 period, spring (31 taxa) and summer (26 taxa) richnesses were somewhat dissimilar but above this median richness and indicative of recovery from previous erosion events (Figure 30).

MCI values have had a very wide range (41 units) at this site, atypical of a site in the upper reaches of a ringplain stream mainly due to headwater erosion effects referenced above. The median value (128 units) however, has been more typical of upper reach sites elsewhere on the ringplain, with the spring, 2014 (130 units) and summer 2015 (126 units) scores insignificantly different and slightly higher (spring) and slightly lower (summer) than the historical median score (128 units). These scores categorised this site as having 'very good' generic health (Table 1) in both spring and summer and, in terms of predictive relationships (Table 2), 'expected' health for the upper reaches of a ringplain stream in both spring and summer. The historical median score (128 units) placed this site in the 'very good' and 'expected' categories for the generic and predictive methods of assessment respectively.

#### 3.2.8.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [29 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| EPHEMEROPTERA | *Austroclima* | 7 | 1 | 3 | | |
| | *Coloburiscus* | 7 | 13 | 45 | A | A |
| | *Deleatidium* | 8 | 29 | 100 | XA | XA |
| | *Nesameletus* | 9 | 19 | 66 | A | VA |
| PLECOPTERA | *Megaleptoperla* | 9 | 11 | 38 | A | A |
| | *Zelandoperla* | 8 | 24 | 83 | A | A |
| COLEOPTERA | Elmidae | 6 | 26 | 90 | VA | XA |
| | Hydraenidae | 8 | 3 | 10 | | |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 11 | 38 | | A |
| | *Costachorema* | 7 | 5 | 17 | | |
| | *Hydrobiosis* | 5 | 1 | 3 | | |
| | *Beraeoptera* | 8 | 12 | 41 | VA | |
| | *Helicopsyche* | 10 | 8 | 28 | | |
| | *Olinga* | 9 | 1 | 3 | | |
| | *Pycnocentrodes* | 5 | 9 | 31 | A | |
| DIPTERA | *Aphrophila* | 5 | 14 | 48 | A | A |
| | Eriopterini | 5 | 4 | 14 | | |
| | *Maoridiamesa* | 3 | 7 | 24 | A | |
| | Orthocladiinae | 2 | 7 | 24 | | A |

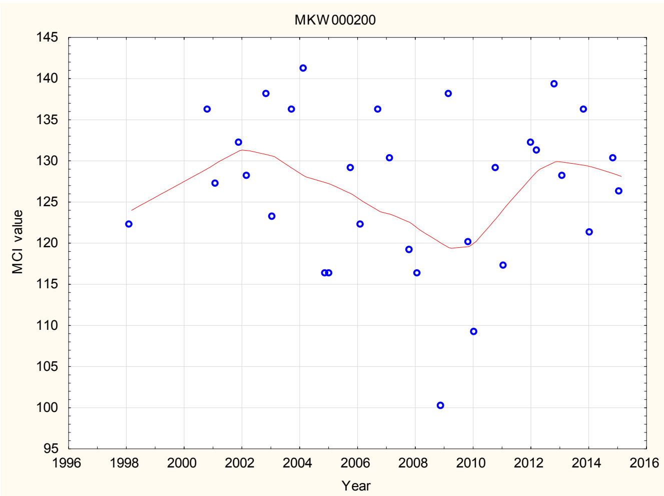
Prior to the current 2014-2015 period, 19 taxa have characterised the community at this site on occasions. These have comprised eight 'highly sensitive', eight 'moderately sensitive', and three 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the upper reaches of a ringplain stream. Predominant taxa have included three 'highly sensitive' taxa [mayflies (*Deleatidium* on every occasion, and *Nesameletus*) and stonefly (*Zelandoperla*)]; one 'moderately sensitive' taxon [elmid beetles]; but no 'tolerant' taxa. All four of these predominant taxa were dominant in the spring, 2014 community together with an additional two 'highly sensitive' taxa (one of which [caddisfly (*Beraeoptera*)] was very abundant), three 'moderately sensitive' taxa, and one 'tolerant' taxon. The summer, 2015 community was characterised by seven of the taxa dominant in spring, together with two additional 'tolerant' taxa, which also previously had been characteristic of this site's communities and one fewer 'highly sensitive' taxon, one fewer 'moderately sensitive' taxon, and one fewer 'tolerant' taxon (Table 35). The relative similarity in the seasonally most dominant taxa composition was evident in the similar $SQMCI_s$ scores which varied by only 0.5 unit (Tables 140 and 141). The taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 41% 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 five units higher than the altitude prediction and seven units above the distance predictive value. The spring, 2014 survey score (130 units) was up to an insignificant nine units higher than the predictive values while the summer, 2015 score (126 units) was from three to five units higher than predictive values. Of the 31 surveys to date at this site, 23% of MCI scores have been less than 121 units while 61% have been greater than 123 units.

#### 3.2.8.1.4 Temporal trends in 1995 to 2015 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 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 = 31
Kendall tau = - 0.039
p level = 0.756 [>FDR, p = 0.819]
N/S at $p < 0.05$

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

No significant temporal trend in the overall very slight decline in MCI scores has been found over the fifteen year monitoring period at this relatively pristine site. Scores decreased following the headwater erosion events, prior to recovery over the more recent five-year period. The variability in LOWESS-smoothed scores (range of

12 units) represented some ecological importance 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 toward 'good' health briefly between 2008 and 2010. 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 fifteen year period, but falling toward 'worse than expected' for two years following the headwater erosion events of 2008 and more recently improving markedly toward the 'better than expected' category.

### 3.2.8.2 Tarata Road site (MKW000300)

#### 3.2.8.2.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken at this mid-reach site at Tarata Road in the Maketawa Stream between March 1998 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Dec 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MKW000300 | 28 | 12-31 | 23 | 90-117 | 106 | 20 | 118 | 22 | 108 |

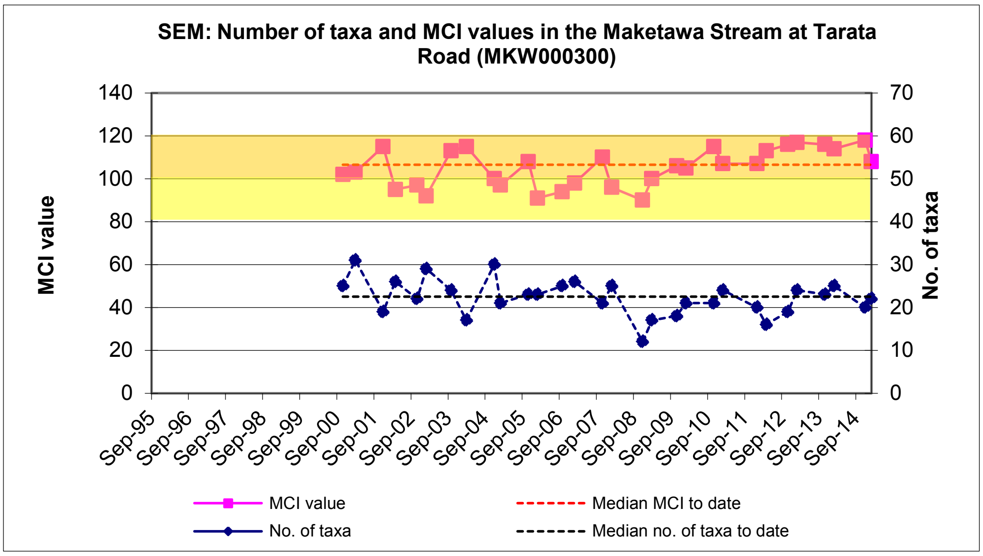



**Figure 32** Number of taxa and MCI values in the Maketawa Stream at Tarata Road

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 2014-2015 period, spring (20 taxa) and summer (22 taxa) richnesses were slightly lower than the median taxa number coincident with minimal change in substrate periphyton cover (patchy) between seasons.

MCI scores have had a relatively wide range (27 units) at this site, more typical of sites in the mid to lower reaches of ringplain streams. The median value (106 units) has been relatively typical of mid-reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (118 units) and summer, 2015 (108 units) scores were within the range typical for such a site and higher than the historical median by two to a significant (Stark, 1998) 12 units. 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' (spring) and 'expected' (summer) health for the mid-reaches of a ringplain stream. The historical median score (106 units) placed this site in the 'good' category for generic health and the 'expected' category for the predictive method of assessment.

#### 3.2.8.2.2 Community composition

Characteristic macroinvertebrate taxa abundant in the communities at this site prior to the 2014-2015 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 April 2014 [28 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **ANNELIDA** | Oligochaeta | 1 | 7 | 25 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 3 | 11 | | |
| | *Coloburiscus* | 7 | 15 | 54 | VA | |
| | *Deleatidium* | 8 | 19 | 68 | XA | A |
| | *Nesameletus* | 9 | 1 | 4 | | |
| **PLECOPTERA** | *Acroperla* | 5 | 1 | 4 | | |
| **COLEOPTERA** | Elmidae | 6 | 9 | 32 | A | A |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 3 | 11 | | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 17 | 61 | A | A |
| | *Costachorema* | 7 | 12 | 43 | A | |
| | *Hydrobiosis* | 5 | 8 | 29 | | |
| | *Neurochorema* | 6 | 3 | 11 | | |
| | *Beraeoptera* | 8 | 3 | 11 | | |
| | *Confluens* | 5 | 2 | 7 | | |
| | *Oxyethira* | 2 | 4 | 14 | | |
| | *Pycnocentrodes* | 5 | 2 | 7 | A | |
| **DIPTERA** | *Aphrophila* | 5 | 22 | 79 | A | A |
| | *Maoridiamesa* | 3 | 20 | 71 | A | A |
| | Orthocladiinae | 2 | 26 | 93 | | A |
| | Tanytarsini | 3 | 8 | 29 | | A |
| | Empididae | 3 | 1 | 4 | | |
| | Muscidae | 3 | 4 | 14 | | |
| | *Austrosimulium* | 3 | 2 | 7 | | |

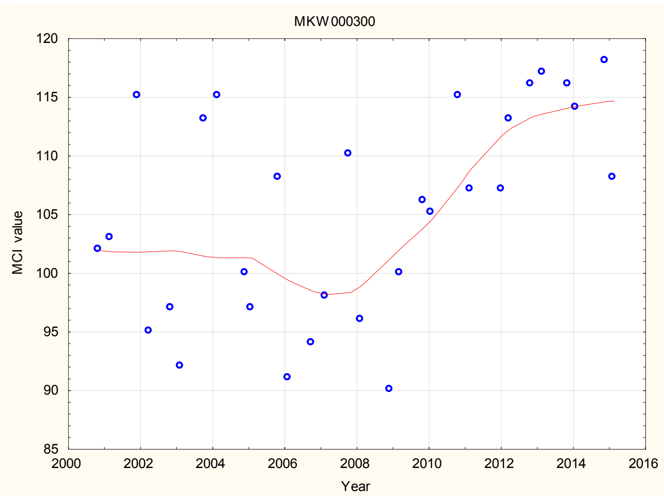
Prior to the current 2014-2015 period 23 taxa have characterised the community at this site on occasions. These have comprised three 'highly sensitive', eleven 'moderately sensitive', and nine 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as might be expected in the mid-reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa, [mayfly (*Coloburiscus*) and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche- Aoteapsyche*) and midges (orthoclads and *Maoridiamesa*)]. Five of these historically predominant characteristic taxa were dominant in the spring 2014 community together with three additional historically characteristic taxa. Overall these comprised one 'highly sensitive', five 'moderately sensitive', and two 'tolerant' taxa, whereas five of these taxa together with another two 'tolerant ' taxa, but three fewer 'moderately sensitive' taxa, comprised the dominant taxa in the summer community. Therefore, five of these teN taxa were dominant in both spring and summer communities (Table 37). These seasonal dominance differences (particularLY the reduction in numerical dominance by up to four 'sensitive taxa) resulted in a marked decrease in summer $SQMCI_s$ score of 2.4 units (Tables 140 and 141). The two taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 54% to 68% 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 (106 units) is six units above the altitude prediction and five units above the predictive distance values, while the spring, 2014 survey score (118 units) was significantly higher (by at least 17 units) while the summer score (108 units) was up to 7 units higher than these predictive values. Of the 30 surveys to date at this site, 30% of MCI scores have been less than 100 units while 63% have been greater than 101 units.

### 3.2.8.2.4 Temporal trends in 1995 to 2015 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 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 = 30
Kendall tau = +0.362
p level = 0.005 [>FDR, p = 0.011]
Significant at $p < 0.05$, and after FDR application at $p < 0.05$
N/S after FDR at $p < 0.01$

**Figure 33** LOWESS trend plot at the Tarata Road site

The increasing trend in MCI scores found over the fifteen year monitoring period has been statistically significant (p >0.01; but not after FDR). Ecological variability in LOWESS-smoothed scores (which have ranged over 17 units) has been important 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 where it remains. 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 for the majority of the period, before very recently improving to 'better than expected'.

#### 3.2.8.3 Discussion

Seasonal MCI values were insignificantly different (four units) between spring and summer at the upper reach (Derby Road) site but lower than the historical median decrease (nine units) recorded for this site over the fifteen year period (Appendix II). Values typically decreased in summer (by 10 units) at the mid-reach site, in comparison with the historical median five unit summer decrease (Appendix II). Seasonal communities at the upper reach site shared 22 common taxa (63% of the 35 taxa found at this site in 2014-2015) compared with 15 shared common taxa (56% of the 27 taxa found in 2014-2015) at the mid-reach site (Tarata Road); dissimilar seasonal changes in community structures at the two sites and typically more pronounced at the site in the mid reaches. The two sites shared 18 common taxa (55% of the 33 taxa) in spring and 18 common taxa (60% of 30 taxa) in summer, indicative of the dissimilarity in spatial community structures particularly in spring and slightly less so in summer, an atypical seasonal difference.

MCI scores typically fell in a downstream direction in both spring (by 12 units) and typically, more markedly in summer (by 18 units), over a stream distance of 15.1 km downstream from the Denby Road site. These falls in MCI scores equated to average rates of decline of 0.8 unit/km in spring increasing to 1.2 units/km in summer, compared with a predicted average 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 average rate of overall decline has been 1.4 MCI units/km over the river's length (i.e. very similar to the predicted average rate). Therefore average rate of decline over the 2014-2015 period was much lower in spring and slightly lower in summer than the long term median average rate to date.

### 3.2.9 Waitara River

The results found by the 2014-2015 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-eight surveys have been undertaken at this lower reach site in the Waitara River between November 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Dec 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WTR000850 | 38 | 9-32 | 19 | 64-107 | 86 | 17 | 89 | 16 | 88 |

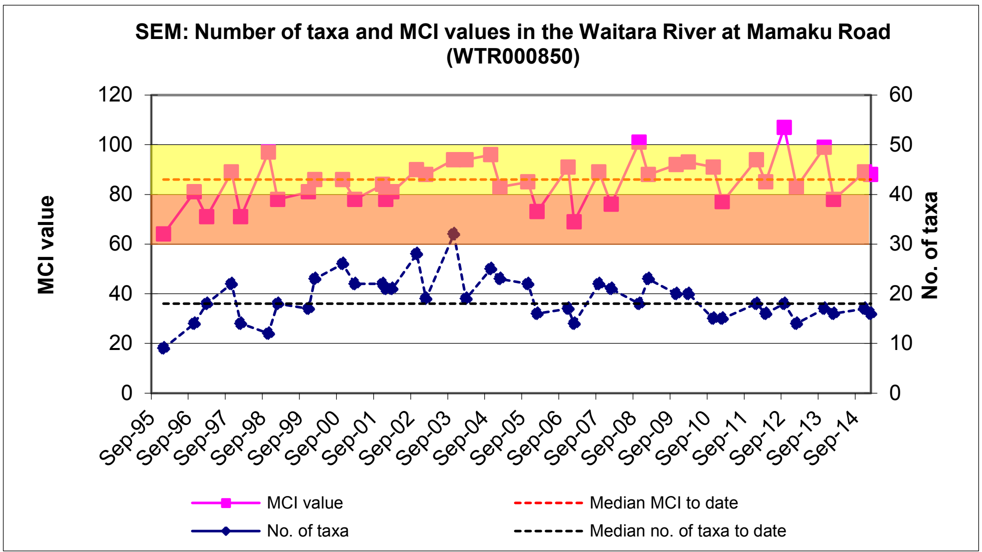



**Figure 34** Numbers of taxa and MCI values in the Waitara River upstream of Methanex at Mamaku Road

A very wide range of richnesses (9 to 32 taxa) has been found with a moderate median richness of 19 taxa (more representative of typical richnesses in the lower reaches of streams and rivers (TRC, 2015a)). During the 2014-2015 period, spring and summer richnesses (17 and 16 taxa respectively) were slightly lower than this median richness.

MCI values have had a very wide range (43 units) at this site which has not been unusual for sites in the lower reaches of large rivers. The historical median value (86 units) has also been typical of lower reach sites elsewhere although lower reach sites in large hill country rivers tended to have had lower MCI values (TRC, 2015a). The spring, 2014 score (89 units) was an insignificant three units higher than the historical median coincidental with patchy periphyton mats and patchy filamentous algal substrate cover. The summer, 2015 score (88 units) was two units above the historical median when periphyton mats were more widespread during a lengthy low flow period.These scores categorised this site as having 'fair' health generically (Table 1) in spring and in summer and, in terms of the predictive altitude relationship (Table 2), 'expected' (spring and summer) health for the lower reaches of a river with some ringplain catchment component. 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 2014-2015 period are listed in Table 39.

**Table 39** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waitara River at Mamaku Road between 1995 and February 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 2 | 5 | | |
| ANNELIDA | Oligochaeta | 1 | 25 | 66 | A | |
| | *Branchiura* | 1 | 1 | 3 | | |
| | Polychaeta | 3 | 2 | 5 | | |
| MOLLUSCA | *Latia* | 5 | 10 | 26 | | |
| | *Potamopyrgus* | 4 | 17 | 45 | | A |
| CRUSTACEA | Tanaidacea | 3 | 1 | 3 | | |
| | *Paratya* | 3 | 13 | 34 | | |
| EPHEMEROPTERA | *Deleatidium* | 8 | 13 | 34 | A | |
| COLEOPTERA | Elmidae | 6 | 1 | 3 | | |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 22 | 58 | VA | VA |
| | *Oxyethira* | 2 | 10 | 26 | | A |
| | *Pycnocentrodes* | 5 | 4 | 11 | | |
| DIPTERA | *Aphrophila* | 5 | 15 | 39 | | |
| | *Maoridiamesa* | 3 | 3 | 8 | A | |
| | Orthocladiinae | 2 | 28 | 74 | VA | XA |
| | Tanytarsini | 3 | 10 | 26 | A | A |
| | *Austrosimulium* | 3 | 1 | 3 | | |

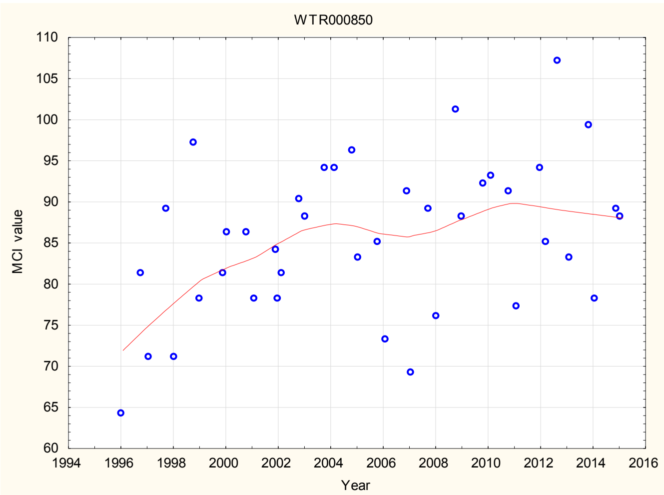
Prior to the current 2014-2015 period, 18 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', four 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain/hill-country river. Predominant taxa have included only three 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche- Aoteapsyche*), and orthoclad midges]. All three of these predominant taxa were dominant in the spring, 2014 community together with one other historically characteristic 'highly sensitive' taxon and two 'tolerant' taxa. The summer, 2015 community was characterised by two additional 'tolerant' taxa and three fewer (one'highly sensitive' and two 'tolerant') taxa than those dominant in spring (Table 39). As a result of these seasonal differences in characteristic taxa, particularly the decrease in numbers of the 'highly sensitive' mayfly taxon and increase in abundance within one 'tolerant' taxon in the summer survey, there was a decrease in $SQMCI_s$ scores of 0.9 unit (Tables 142 and 143) in summer. The taxa recorded as very or extremely abundant during spring/summer had characterised this site's communities on 58% to 74% of 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 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 85 units for this site. The historical site median (86 units) was one unit higher than this altitude prediction while the spring, 2014 (89 units) score was higher than this predictive value by four units and the summer, 2015 score (88 units) was three units higher than the predictive value. These two surveys' scores were also 12 units and 11 unit higher than the median MCI (77 units) found from 226 previous surveys of 'control' sites below 25 m asl in hill country catchment streams and rivers (TRC, 2015a). Of the 40 surveys to date at this river site, 13% of MCI scores have been less than 75 units while 50% have been greater than 86 units.

### 3.2.9.3 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty years 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 = 40
Kendall tau = +0.256
p level = 0.020 [>FDR, p = 0.037]
Significant at p< 0.05; and after FDR application
N/S at p< 0.01

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

Despite a statistically very significant improvement in MCI scores over the first ten years of monitoring, the variability in more recent scores has resulted in an overall positive trend for the twenty year period which has not been as significant statistically (p > 0.01 after FDR). This may be coincident with the earlier assessment that linked improvement with climatic factors in this large, predominantly eastern hill country catchment. The range of LOWESS-smoothed scores (18 units) has been ecologically important over the period. These MCI scores have been indicative of a general improvement from 'poor' (in the first few years) 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 twenty year period.

#### 3.2.9.4 Discussion

Seasonal MCI values typically decreased between spring and summer (but only by one unit) at this lower reach site with the percentage community compositions of 'tolerant' taxa increasing by 3% in summer. This decrease was much lower than the seasonal historical median decrease (10 units) for this site (Appendix II). Seasonal communities at this site shared only 11 common taxa (50% of the 22 taxa found at this site in 2014-2015), a low percentage of common taxa which was not reflected in the minimal difference in MCI values between the seasonal surveys. An increase in abundance of one 'tolerant' taxon and decrease in one 'highly sensitive' taxon abundance in particular, accounted for the decrease in $SQMCI_s$ value (0.9 unit) in summer, coincident with patchy periphyton substrate cover in spring and characteristically more widespread mats under late summer, lengthy low flow conditions.

## 3.2.10 Mangati Stream

The results found by the 2014-2015 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-nine surveys have been undertaken at this site in the mid reaches of this small lowland, coastal stream draining an industrial catchment between September 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Dec 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MGT000488 | 39 | 9-29 | 16 | 56-91 | 78 | 12 | 78 | 16 | 73 |

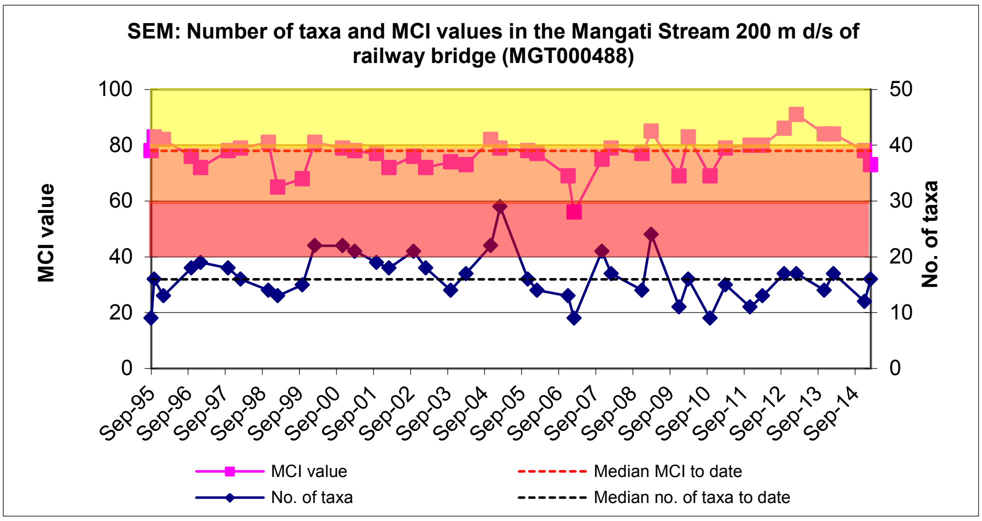



**Figure 36** Numbers of taxa and MCI values in the Mangati Stream downstream of the railbridge

A very wide range of richnesses (9 to 29 taxa) has been found; with a median richness of 16 taxa (more representative of typical richnesses in swampy reaches of small coastal streams (TRC, 2015a)). During the 2014-2015 period, spring (12 taxa) was lower than summer (16 taxa) richnesses and up to four taxa lower than this median richness.

MCI values have had a wide range (35 units) at this site, relatively typical of a site in a small coastal stream. The median value (78 units) also has been typical of such streams elsewhere on the ringplain, and the spring, 2014 (78 units) and summer, 2015 (73 units) scores, were relatively similar and within five units of the historical median. These scores were also six to a significant 11 units higher than the median score previously recorded by 49 surveys at ‘control’ sites in lowland coastal streams at altitudes between 25 m and 50 m asl (TRC, 2015a).

These scores categorised this site as having 'poor' health generically (Table 1) in spring and summer. The historical median score (78 units) placed this site in the 'poor' health 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 2014-2015 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 February 2014 [39 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| PLATYHELMINTHES | *Cura* | 3 | 5 | 13 | | |
| NEMERTEA | Nemertea | 3 | 3 | 8 | | |
| ANNELIDA | Oligochaeta | 1 | 33 | 85 | | VA |
| | Lumbricidae | 5 | 1 | 3 | | |
| MOLLUSCA | *Physa* | 3 | 4 | 10 | | |
| | *Potamopyrgus* | 4 | 36 | 92 | A | A |
| | Sphaeriidae | 3 | 1 | 3 | | |
| CRUSTACEA | Ostracoda | 1 | 9 | 23 | | |
| | *Paracalliope* | 5 | 33 | 85 | VA | XA |
| | *Phreatogammarus* | 5 | 1 | 3 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 12 | 31 | | |
| | *Zephlebia group* | 7 | 1 | 3 | | |
| HEMIPTERA | *Microvelia* | 3 | 1 | 3 | | |
| TRICHOPTERA | *Hydrobiosis* | 5 | 1 | 3 | | |
| | *Polyplectropus* | 6 | 1 | 3 | | |
| | *Oxyethira* | 2 | 3 | 8 | | |
| DIPTERA | Eriopterini | 5 | 1 | 3 | | |
| | Orthocladiinae | 2 | 18 | 46 | | |
| | *Polypedilum* | 3 | 3 | 8 | | |
| | *Austrosimulium* | 3 | 22 | 56 | | |

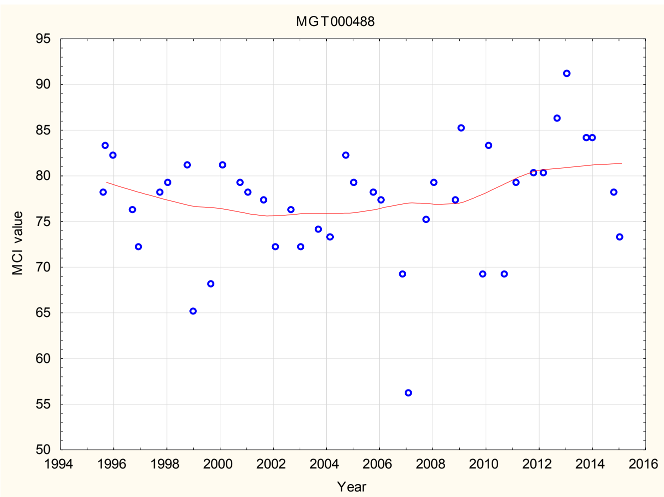
Prior to the current 2014-2015 period, 20 taxa have characterised the community at this site on occasions. These have comprised eight 'moderately sensitive' and twelve 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa as would be expected in the swampier upper reach of a softer bottom, macrophyte 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 two taxa (both predominant) were characteristic of the spring, 2014 community. The summer, 2015 community was characterised by both of the taxa dominant in spring, together with one additional 'tolerant' taxon, which also had been predominantly characteristic of this site's communities in the past (Table 41). The increase in abundance of 'tolerant' oligochaete worms, despite an increased abundance of 'moderately sensitive' amphipods in summer was reflected in the small decrease (of 0.3 unit) between spring and summer $SQMCI_s$ scores (Tables 144 and 145). The two taxa recorded as extremely or very abundant during spring and/or summer had characterised this site's communities on 85% of past surveys.

#### 3.2.10.1.3 Predicted stream 'health'

The Mangati Stream site downstream of the railbridge is in the mid, swampier reaches of a small lowland, 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 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 41
Kendall tau = + 0.127
p level = 0.241[>FDR, p = 0.322]
N/S at $p < 0.05$

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

There was a positive overall trend identified in the MCI scores, which had no statistical significance, with a more pronounced improvement since 2009. This site's scores have had a LOWESS-smoothed range of nine units indicative of marginal ecological importance over the period.

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

### 3.2.10.2 Te Rima Place, Bell Block site (MGT000520)

#### 3.2.10.2.1 Taxa richness and MCI

Thirty-nine surveys have been undertaken at this lower reach site at SH45 in the Mangati Stream between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Dec 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MGT000520 | 39 | 3-22 | 10 | 44-78 | 65 | 11 | 67 | 17 | 72 |

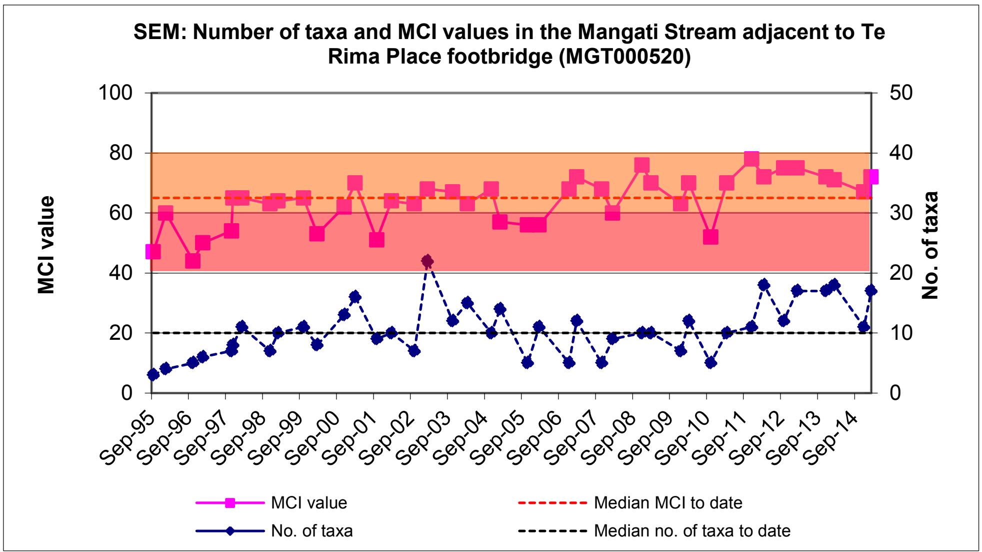



**Figure 38** Numbers of taxa and MCI values in the Mangati Stream at Te Rima Place footbridge

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 lowland, coastal streams. During the 2014-2015 period, spring (11 taxa) richness was much lower than summer (17 taxa) richness but from one to seven taxa above the median richness.

MCI scores have had a relatively wide range (34 units) at this site, more typical of sites in the lower reaches of small lowland, coastal streams. The median value (65 units) also has been relatively typical of lower reach sites in coastal streams with the spring, 2014 (67 units) and summer, 2015 (72 units) scores within the range typical for such a site and up to seven units above the historical median. However, the scores were six to 11 units below the median score found by 194 surveys at 'control sites' in similar lowland coastal streams at altitudes of less than 25 m asl (TRC, 2015a). These scores categorised this site as having 'poor' (spring and summer) health generically (Table 1). The historical median score (65 units) also 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 2014-2015 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 February 2014 [39 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 2 | 5 | | |
| ANNELIDA | Oligochaeta | 1 | 39 | 100 | XA | VA |
| MOLLUSCA | *Potamopyrgus* | 4 | 21 | 54 | XA | XA |
| CRUSTACEA | Ostracoda | 1 | 1 | 3 | | |
| TRICHOPTERA | *Oxyethira* | 2 | 2 | 5 | | |
| | *Triplectides* | 5 | 5 | 13 | | A |
| DIPTERA | Orthocladiinae | 2 | 28 | 72 | A | |
| | Empididae | 3 | 2 | 5 | A | |
| | *Austrosimulium* | 3 | 6 | 15 | | |

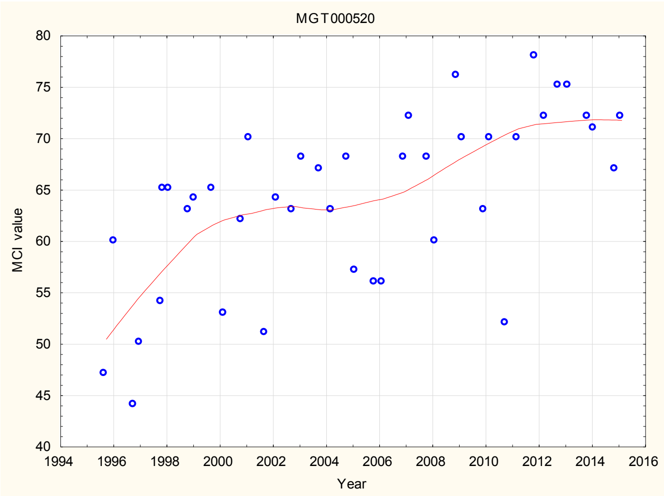
Prior to the current 2014-2015 period small numbers of taxa (up to nine) have been characteristeristic of the community at this site on occasions. These have been comprised of one 'moderately sensitive' and eight 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a small lowland, coastal ringplain stream. Predominant taxa have included no 'moderately sensitive' taxa but three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges]. Only four of the historically characteristic taxa (all 'tolerant' taxa) were dominant in the spring, 2014 community. Two of these and one 'moderately sensitive' taxa comprised the dominant taxa in the summer community. The decrease in abundance of 'very tolerant' oligochaete worms in summer was reflected in the difference in seasonal $SQMCI_s$ scores which increased by 1.0 unit in summer (Tables 144 and 145). Two of these five taxa were dominant in both spring and summer communities (Table 43). The two taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 54% 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 gravel-bottomed reaches of a small lowland, 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 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 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 39.




N = 41
Kendall tau = + 0.485
p level = < 0.0001 [>FDR, p < 0.0001]
Significant at p < 0.05 and p < 0.01 after FDR application

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

A positive temporal trend in MCI scores, statistically significant (p < 0.01) prior to and after FDR analysis, indicated continued improvement coincident with better control and treatment of industrial point source discharges in the upper and mid-catchment and wetland installation (stormwater interception) in mid catchment with this improvement continuing in recent years. The LOWESS-smoothed range of scores (21 units) has been ecologically important with MCI scores indicative of a shift from 'very poor' over the first four years to 'poor' generic stream health (Table 1) during the period.

This trend of improvement in stream 'health' at this site has been 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 positive influence.

### 3.2.10.3 Discussion

Seasonal MCI values showed a decrease of five units between spring and summer at the upstream site, where seasonal median values have been within one unit (Appendix II), and atypically increased by five units at the lower site due to minor changes (5% to 8%) in the percentage compositions of 'tolerant' taxa in the summer communities. Seasonal communities at the upper reach site shared only six common taxa (27% of the 22 taxa found at this site in 2014-2015) compared with nine shared common taxa (47% of the 19 taxa) at the lower reaches site, a much more pronounced seasonal change in community structure at the upper reach site. However, MCI values changed insignificantly between seasons at both sites where long-term median scores have shown very small one to two units summer increases to date (Appendix II). The two sites shared only five taxa (28% of the 18 taxa) in spring and eight taxa (32% of 25 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and in summer.

MCI score typically fell in a downstream direction in both spring (by 11 units) and summer (by one unit), over a stream distance of 1.4 km equating to very different average rates of decline (7.9 and 0.7 MCI units/km). This variability can be typical of a small lowland developed coastal catchment stream.

Using the long-term median SEM MCI scores for both sites (Appendix II), the overall average rate of decline has been 9.3 MCI units/km over the surveyed length of the stream. Therefore rates of decline over the 2014-2015 period were lower in spring and very much lower in summer compared to this historical median average rate.

## 3.2.11 Waimoku Stream

The results found by the 2014-2015 surveys are presented in Table 146 and Table 147, Appendix I.

### 3.2.11.1 Lucy's Gully site (WMK000100)

#### 3.2.11.1.1 Taxa richness and MCI

Thirty surveys have been undertaken at this upper reach site in the Waimoku Stream (in the Kaitake Ranges) between December 1999 and February 2014. 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 2014' and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Jan 2015 | | Mar 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WMK000100 | 30 | 22-38 | 31 | 121-141 | 131 | 30 | 127 | 31 | 131 |

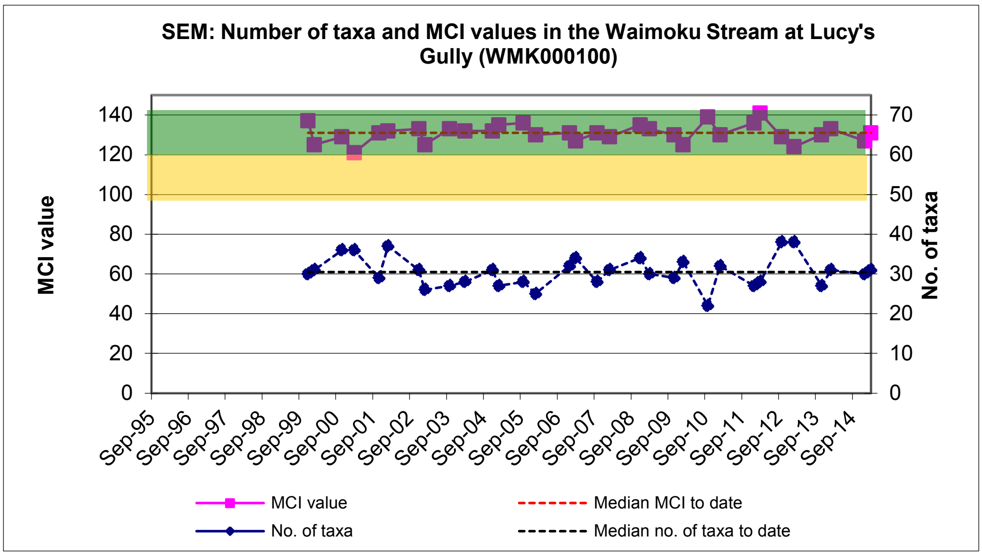



**Figure 40** Numbers of taxa and MCI values in the Waimoku Stream at Lucy's Gully

A moderate range of richnesses (22 to 38 taxa) has been found, with a median richness of 31 taxa which is more representative of typical richnesses in the upper reaches of ringplain streams and rivers. During the 2014-2015 period, 'spring' (30 taxa) and summer (31 taxa) richnesses were very similar, and within one taxon of this median richness.

MCI values also have had a moderate range (20 units) at this site, slightly wider than typical of a site in the upper reaches of a ringplain stream. The median value (131 units) however, has been typical of upper reach sites elsewhere on the ringplain (TRC, 2015a), and the 'spring, 2014' (127 units) and summer, 2015 (131 units) scores were similar and within four units of the historical median score. 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), 'expected' health for the upper reaches of a ringplain stream within the National Park on 'spring' and summer occasions. 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 2014-2015 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 2014 [32 surveys], and by the 'spring 2014' and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | 'Spring 2014' | Summer 2015 |
| ANNELIDA | Oligochaeta | 1 | 3 | 10 | | |
| MOLLUSCA | *Potamopyrgus* | 4 | 5 | 17 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 22 | 73 | A | |
| | *Coloburiscus* | 7 | 30 | 100 | VA | A |
| | *Deleatidium* | 8 | 27 | 90 | VA | |
| | *Ichthybotus* | 8 | 1 | 3 | | |
| | *Zephlebia group* | 7 | 26 | 87 | A | VA |
| PLECOPTERA | *Austroperla* | 9 | 22 | 73 | A | A |
| | *Stenoperla* | 10 | 2 | 7 | | |
| | *Zelandobius* | 5 | 1 | 3 | | |
| COLEOPTERA | Elmidae | 6 | 2 | 7 | | |
| | Ptilodactylidae | 8 | 5 | 17 | | |
| MEGALOPTERA | *Archichauliodes* | 7 | 4 | 13 | | |
| TRICHOPTERA | *Hydrobiosella* | 9 | 7 | 23 | | |
| | *Hydropsyche (Orthopsyche)* | 9 | 30 | 100 | VA | VA |
| DIPTERA | Orthocladiinae | 2 | 19 | 63 | | |
| | *Polypedilum* | 3 | 6 | 20 | VA | A |

Prior to the current 2014-2015 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 (*Hydropsyche-Orthopsyche*)]; three 'moderately sensitive' taxa [mayflies (*Austroclima, Coloburiscus,* and *Zephlebia* group)]; and one 'tolerant' taxon [orthoclad midges]. Six of these predominant taxa were characteristic of the 'spring, 2014' community together with one other 'tolerant' taxon. The summer, 2015 community was characterised by all but two of the taxa dominant in spring all, but one of which were predominant taxa (Table 45). Despite a marked reduction in abundance within one 'highly sensitive' taxon in summer, an increase in abundance of one 'moderately sensitive' taxon together with a decreased abundance of one 'tolerant' taxon resulted in a small seasonal increase of 0.6 unit in $SQMCI_s$ score in summer. Taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 20% to 100% of past surveys.

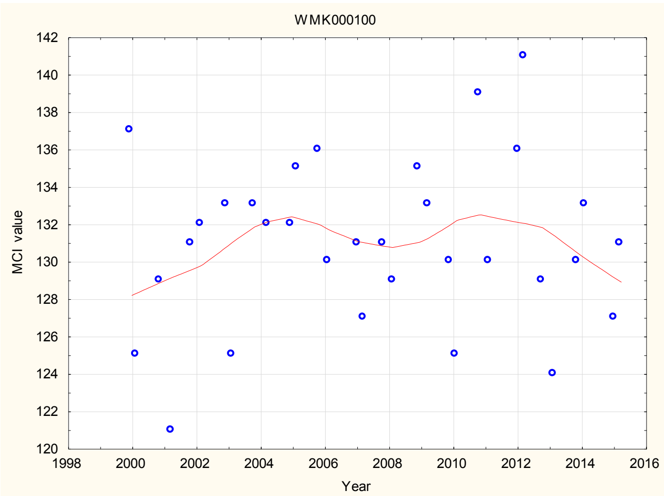
#### 3.2.11.1.3 Predicted stream 'health'

The Waimoku Stream site at Lucy's Gully is within the Kaitaka Ranges of the National Park boundary but at an altitude of 160 m asl and only 4km from the coast.

Relationships for ringplain streams developed between MCI and 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 one unit less than the distance predictive value. The 'spring, 2014' survey score (127 units) was five units below the distance predictive value while the summer score (131 units) was one unit below the distance predictive value. Of the 32 surveys to date at this site, no MCI scores have been less than 101 units while 34% have been greater than 132 units.

#### 3.2.11.1.4 Temporal trends in 1995 to 2015 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 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 = 32
Kendall tau = +0.012
p level = 0.920 [>FDR, p = 0.920]
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 sixteen year period at this pristine site within the National Park with minimal improvement apparent overall. The LOWESS-smoothed range of scores (four units) has not been ecologically importantant 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' through the sixteen year period.

### 3.2.11.2 Oakura Beach site (WMK000298)

#### 3.2.11.2.1 Taxa richness and MCI

Thirty surveys have been undertaken at this lower reach site at Oakura Beach in the Waimoku Stream between December 1999 and February 2014. 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 2014' and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Jan 2015 | | Mar 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WMK000298 | 30 | 10-27 | 21 | 75-101 | 90 | 23 | 91 | 20 | 93 |

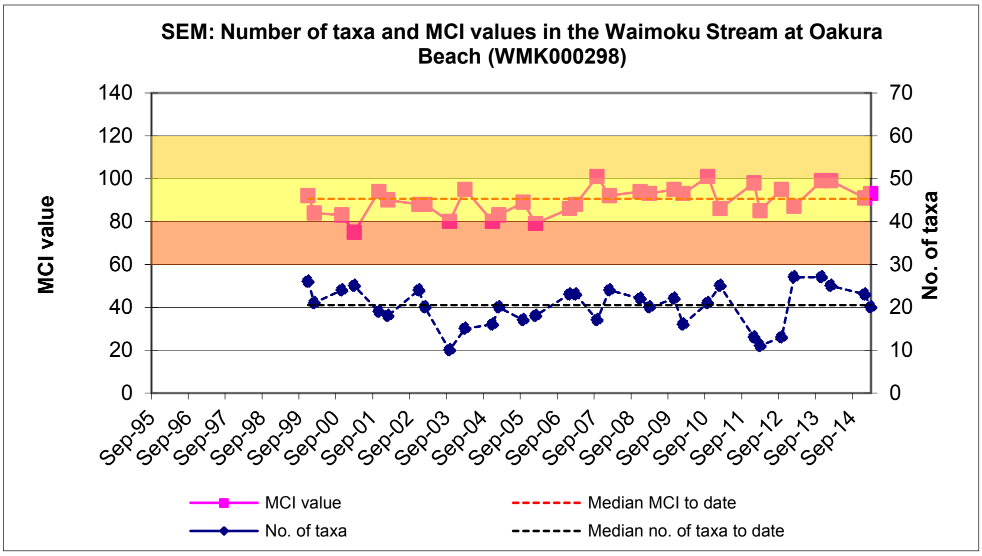



**Figure 42** Numbers of taxa and MCI values in the Waimoku Stream at Oakura Beach

A wide range of richness (10 to 27 taxa) has been found; wider than might be expected, with a median richness of 20 taxa which was more representative of typical richnesses in ringplain streams and rivers in the lower reaches. During the 2014-2015 period, 'spring' (23 taxa) and summer (20 taxa) richnesses were relatively similar and within two taxa of the median taxa number coincident with patchy periphyton substrate cover in spring and more widespread cover in summer.

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 (90 units) has been relatively typical of lower reach sites elsewhere on the ringplain. The 'spring, 2014' (91 units) and summer, 2015 (93 units) scores were similar and within the range typical for such a site and higher than the historical median by one to three units. 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 summer) health for the coastal lower reaches of a ringplain stream. The historical median score (90 units) placed this site in the 'fair' category for generic and 'expected' category for predictive methods of assessment.

### 3.2.11.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [30 surveys], and by the 'spring 2014' and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | 'Spring 2014' | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 3 | 10 | | |
| ANNELIDA | Oligochaeta | 1 | 22 | 73 | A | A |
| MOLLUSCA | *Potamopyrgus* | 4 | 20 | 67 | XA | VA |
| | Sphaeriidae | 3 | 1 | 3 | | |
| CRUSTACEA | Ostracoda | 1 | 1 | 3 | | |
| | *Paratya* | 3 | 1 | 3 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 7 | 23 | | |
| | *Coloburiscus* | 7 | 5 | 17 | | |
| | *Deleatidium* | 8 | 2 | 7 | | |
| | *Zephlebia group* | 7 | 2 | 7 | | |
| COLEOPTERA | Elmidae | 6 | 2 | 7 | | |
| TRICHOPTERA | *Hydrobiosis* | 5 | 5 | 17 | A | |
| | *Oxyethira* | 2 | 3 | 10 | | |
| | *Pycnocentrodes* | 5 | 1 | 3 | | |
| | *Triplectides* | 5 | 4 | 13 | | |
| DIPTERA | *Aphrophila* | 5 | 8 | 27 | | |
| | *Maoridiamesa* | 3 | 2 | 7 | A | |
| | Orthocladiinae | 2 | 28 | 93 | A | A |
| | *Polypedilum* | 3 | 5 | 17 | | |
| | Empididae | 3 | 2 | 7 | | |
| | *Austrosimulium* | 3 | 12 | 40 | | |

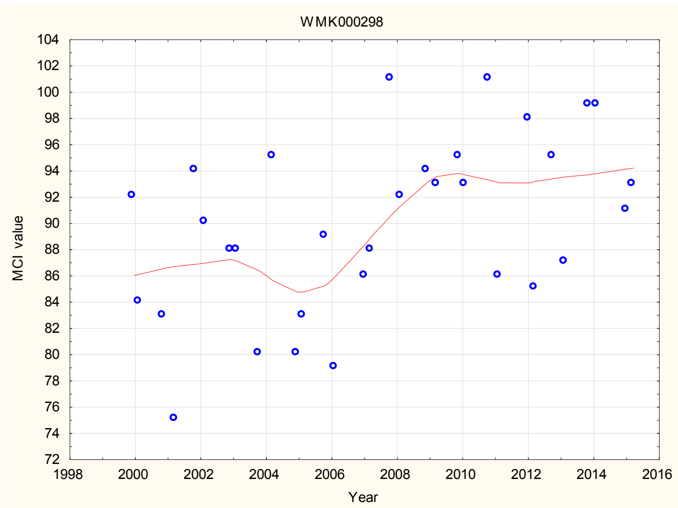
Prior to the current 2014-2015 period 19 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', six 'moderately sensitive', and twelve 'tolerant' taxa i.e. a majority of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly' or 'moderately sensitive' taxa, but three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges]. Five of the historically characteristic taxa were dominant in the 'spring 2014' community. These included one 'moderately sensitive' and four 'tolerant' taxa. Three 'of these taxa (all 'tolerant' taxa) comprised the dominant taxa in the summer community. Only three taxa were dominant in both spring and summer communities (Table 47) but numerical dominance by 'tolerant' snails in particular in both seasons was responsible for the very similar $SQMCI_S$ scores (within 0.1 unit) between seasons. The one taxon recorded as very or extremely abundant during spring and/or summer has characterised this site's communities on 67% of past surveys' occasions.

### 3.2.11.2.3 Predicted stream 'health'

The Waimoku Stream at Oakura Beach site at an altitude of 1 m asl is only 4 km downstream of the National Park boundary. Relationships for ringplain streams developed between MCI and 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 (90 units) is slightly higher (by five units) than the altitude prediction but 26 units lower than the predictive distance value, due to the atypically short distance between the National Park boundary and the coast for a ringplain stream. The spring, 2014 and summer, 2015 scores (91 and 93 units) were higher than the predictive altitude value by an insignificant six and eight units. Of the 32 surveys to date at this site, 22% of MCI scores have been less than 85 units while no scores have been greater than 116 units nor within a significant 15 units of this score.

#### 3.2.11.2.4 Temporal trends in 1995 to 2015 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 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 = 32
Kendall tau = +0.320
p level = 0.010 [>FDR, p = 0.020
Significant at $p < 0.05$ level;
N/S at $p < 0.01$ after FDR

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

An overall positive temporal trend in MCI scores has been recorded during the sixteen year monitoring period with this trend statistically significant at $p < 0.05$ but not at $p < 0.01$ or after FDR. The range of LOWESS-smoothed scores (nine 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 altitude relationships (Table 2) for a site in the lower reaches of a ringplain stream, the stream health improved from 'expected' toward 'better than expected' over the 2008 to 2015 period.

### 3.2.11.3 Discussion

Seasonal MCI values were insignificantly higher (by four units) in summer compared with the historical median summer decrease of one unit at the upper reach Lucy's Gully site. An atypical, but minimal seasonal increase was found at the lower reach site when compared with the historical seasonal summer median decrease of four units (Appendix II), and the percentage composition of 'tolerant' taxa atypically decreased by 3% between spring and summer communities. Seasonal communities at the upper reach site shared 26 common taxa (74% of the 35 taxa) compared with 14 shared common taxa (48% of the 29 taxa) at the lower reach site (Oakura Beach); a more pronounced and typical seasonal difference in community structure at the lower reach site. The two sites shared 12 common taxa (29% of the 41 taxa) in spring and 13 common taxa (34% of 38 taxa) in summer, indicative of the dissimilarity in spatial community structures in spring and to a slightly lesser extent in summer.

MCI score typically fell in a downstream direction in spring (by 36 units) and slightly more in summer (by 38 units), over a stream distance of 4.0 km downstream from the National Park boundary. These falls in MCI scores equated to average rates of decline of 9.0 units/km in spring increasing to 9.5 units/km in summer. These were far higher than the predicted average 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 very 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 average rate of overall decline has been 10.0 MCI units/km (9.8 units/km in spring and 10.5 units/km in summer) over the surveyed length. Therefore average rates of decline over the 2014-2015 period were lower in both spring and summer than the overall median average rate and median average seasonal rates to date.

### 3.2.12 Waiau Stream

The results found by the 2014-2015 surveys are presented in Table 148 and Table 149, Appendix I for this small lowland stream.

#### 3.2.12.1 Inland North site (WAI000110)

##### 3.2.12.1.1 Taxa richness and MCI

Thirty-one surveys have been undertaken in this mid-reach site in the Waiau Stream between February 1998 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1998 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WAI000110 | 31 | 17-30 | 21 | 80-100 | 90 | 22 | 99 | 19 | 88 |

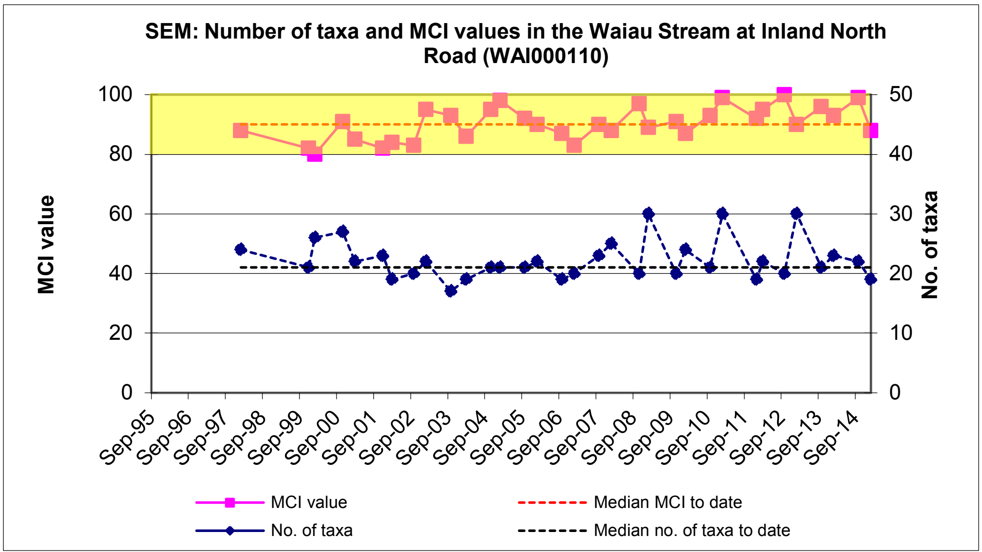



**Figure 44** Numbers of taxa and MCI values in the Waiau Stream at the Inland North Road site

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 coastal streams where a median richness of 20 taxa has been recorded from 98 previous surveys of 'control' sites at similar altitudes (TRC, 2015a)). During the 2014-2015 period, spring (22 taxa) and summer (19 taxa) richnesses were relatively similar and slightly above this median richness in spring and slightly below in summer coincident with an increase in summer periphyton substrate cover.

MCI values have had a moderate range (20 units) to date at this site. The median value (90 units) is more typical of scores at sites in the lower reaches of small lowland streams and rivers, however. The spring, 2014 (99 units) score was higher than typical for this site and only one unit below the historical maximum, but the summer score was significantly (Stark, 1998) 11 units lower than the spring score. These scores varied between nine units higher than the historical median in spring and two units lower than this median in summer and categorised this site as having 'fair' (spring and summer) health generically (Table 1). They were significantly higher (Stark, 1998) than the median MCI score (78 units) recorded by 98 previous surveys of 'control' sites between 50 and 79 m asl in small, lowland coastal streams in Taranaki (TRC, 2015a). The historical median score (90 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 in the region.

#### 3.2.12.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [31 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 4 | 13 | | |
| ANNELIDA | Oligochaeta | 1 | 20 | 65 | VA | A |
| MOLLUSCA | *Latia* | 5 | 11 | 35 | | A |
| | *Potamopyrgus* | 4 | 30 | 97 | VA | VA |
| CRUSTACEA | *Paracalliope* | 5 | 16 | 52 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 28 | 90 | VA | VA |
| | *Coloburiscus* | 7 | 1 | 3 | | |
| PLECOPTERA | *Zelandobius* | 5 | 1 | 3 | | |
| COLEOPTERA | Elmidae | 6 | 31 | 100 | VA | VA |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 29 | 94 | VA | VA |
| | *Hydrobiosis* | 5 | 11 | 35 | A | |
| | *Hudsonema* | 6 | 3 | 10 | | |
| | *Oxyethira* | 2 | 7 | 23 | | |
| | *Pycnocentria* | 7 | 14 | 45 | VA | |
| | *Pycnocentrodes* | 5 | 25 | 81 | VA | A |
| DIPTERA | *Aphrophila* | 5 | 15 | 48 | A | |
| | *Maoridiamesa* | 3 | 1 | 3 | | |
| | Orthocladiinae | 2 | 23 | 74 | | |
| | *Polypedilum* | 3 | 1 | 3 | | |
| | Tanytarsini | 3 | 1 | 3 | | |
| | *Austrosimulium* | 3 | 5 | 16 | | A |
| ACARINA | Acarina | 5 | 1 | 3 | | |

Prior to the current 2014-2015 period, 22 taxa had characterised the community at this site on occasions. These have comprised twelve 'moderately sensitive' and ten 'tolerant' taxa i.e. an absence of 'highly sensitive' taxa and a relatively high proportion of 'tolerant' taxa as would be expected in the mid reaches of a lowland, coastal stream.

Predominant taxa have included four 'moderately sensitive' taxa [amphipod (*Paracalliope*), mayfly (*Austroclima*), elmid beetles, and stony-cased caddisfly

(*Pycnocentrodes*)] and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche -Aoteapsyche*), and orthoclad midges].

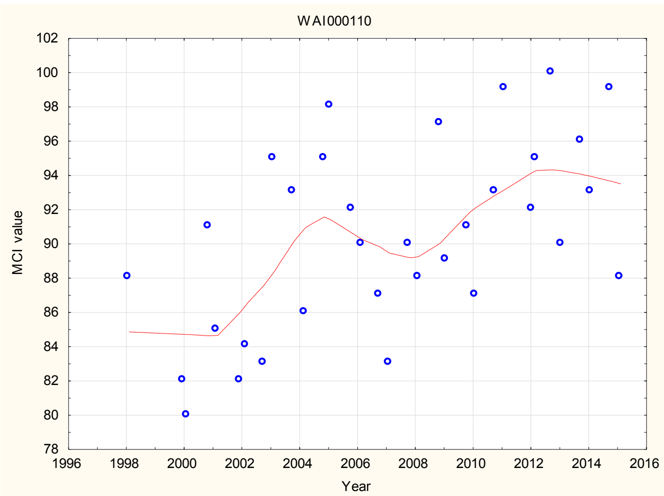
Nine of the historically characteristic taxa were dominant in the spring, 2014 community and comprised six of the predominant taxa (above). The summer, 2015 community was characterised by six of the taxa dominant in spring, together with an additional one 'moderately sensitive' and one 'tolerant' taxa, and three fewer 'moderately sensitive' taxa (Table 49). Despite several differences in characteristic taxa at the time of the summer survey there was minimal change in $SQMCI_s$ scores (0.1 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 45% to 100% of past surveys.

### 3.2.12.1.3 Predicted stream 'health'

The Waiau Stream rises at an elevation of less than 100 m asl as seepage beyond the ringplain and the site at Inland North Road is in the mid reaches at an altitude of 50 m asl. Relationships for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), therefore are not applicable in this type of small lowland coastal stream.

### 3.2.12.1.4 Temporal trends in 1998 to 2015 data

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the seventeen 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 = 33
Kendall tau = +0.393
p level = 0.001 [>FDR, p = 0.004]
Significant at p < 0.05 level and p< 0.01 after FDR application

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

A strong overall improving temporal trend in MCI scores has been found which remains statistically significant (p < 0.01) after FDR application over the seventeen year monitoring term at this site, with the initial trend of increasing scores having been followed by some decline in scores improving again to scores slightly above those recorded in mid-programme. The range of LOWESS-smoothed scores (nine units) has been of marginal ecological importance. LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) throughout the period.

#### 3.2.12.2 Discussion

Seasonal MCI values typically decreased between spring and summer (but by a significant 11 units) at this mid reach site of a lowland stream where the percentage composition of 'tolerant' taxa increased by 15% in the summer community coincident with a more widespread seasonal increase in periphyton mats substrate cover. Historical seasonal median scores (Appendix II) have indicated a four unit summer decrease at this site. Seasonal communities at this site shared 16 common taxa (64% of the 25 taxa found at this site in 2014-2015), a moderate percentage of common taxa for this mid reach site in a lowland, coastal stream, although the relatively large seasonal difference of 11 units in MCI values reflected the proportional decrease in 'moderately sensitive' taxa between seasons.

## 3.2.13 Punehu Stream

The results of the spring (2014) and summer (2014-2015) 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-eight surveys have been undertaken in the Punehu Stream between October 1995 and February 2014 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| PNH000200 | 38 | 19-31 | 27 | 104-137 | 122 | 20 | 133 | 26 | 126 |

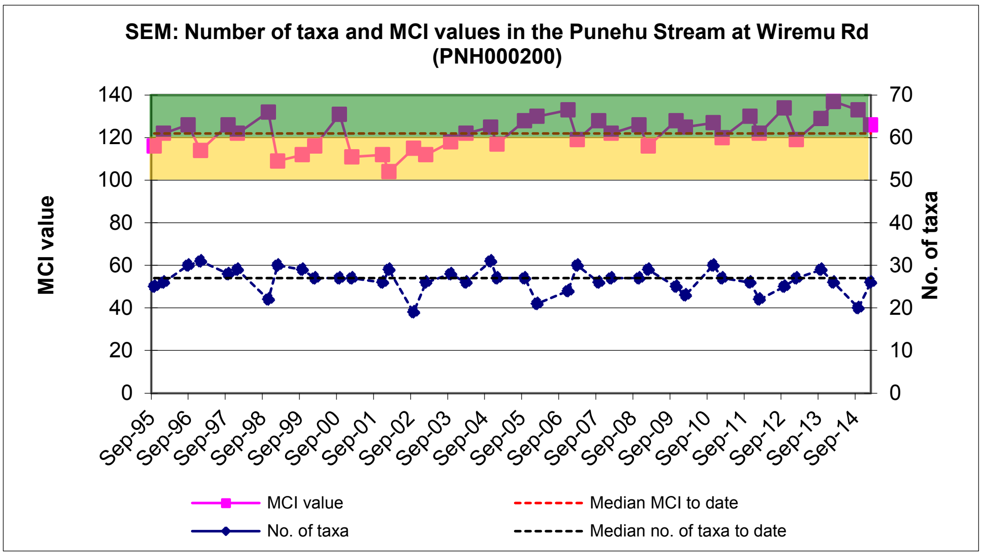



**Figure 46** Numbers of taxa and MCI values in the Punehu Stream at Wiremu Road

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 (TRC, 2015a)). During the 2014-2015 period, spring richness (20 taxa) was toward the minimum richness recorded to date and dissimilar to summer (26 taxa) richness which was very similar to the median richness.

MCI values have had a moderate range (33 units) at this site, typical of a site in the (upper) mid reaches of a ringplain stream in more open farmland. The median value (122 units) has been typical of mid reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (133 units) and summer, 2015 (126 units) scores were a significant 11 units and an insignificant four units above the historical median respectively. These scores categorised this site as having 'very good' generic health (Table 1) in spring and in summer and, in terms of predictive relationships (Table 2), 'better than expected' health for the (upper) mid reaches of a ringplain stream both in spring and in summer. The historical median score (122 units) placed this site in the 'very good' and '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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **ANNELIDA** | Oligochaeta | 1 | 4 | 11 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 1 | 3 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 6 | 16 | | A |
| | *Coloburiscus* | 7 | 35 | 92 | VA | A |
| | *Deleatidium* | 8 | 38 | 100 | XA | XA |
| | *Nesameletus* | 9 | 33 | 87 | VA | XA |
| **PLECOPTERA** | *Acroperla* | 5 | 2 | 5 | | |
| | *Megaleptoperla* | 9 | 5 | 13 | | |
| | *Zelandoperla* | 8 | 28 | 74 | VA | |
| **COLEOPTERA** | Elmidae | 6 | 38 | 100 | A | VA |
| | Hydraenidae | 8 | 5 | 13 | | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 3 | 8 | | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 27 | 71 | | A |
| | *Costachorema* | 7 | 21 | 55 | | |
| | *Hydrobiosis* | 5 | 10 | 26 | | A |
| | *Beraeoptera* | 8 | 18 | 47 | | |
| | *Helicopsyche* | 10 | 4 | 11 | | |
| | *Olinga* | 9 | 2 | 5 | | |
| | *Oxyethira* | 2 | 1 | 3 | | |
| | *Pycnocentrodes* | 5 | 24 | 63 | | |
| **DIPTERA** | *Aphrophila* | 5 | 5 | 13 | | |
| | Eriopterini | 5 | 8 | 21 | | |
| | *Maoridiamesa* | 3 | 15 | 39 | | A |
| | Orthocladiinae | 2 | 19 | 50 | | A |
| | Empididae | 3 | 1 | 3 | | |

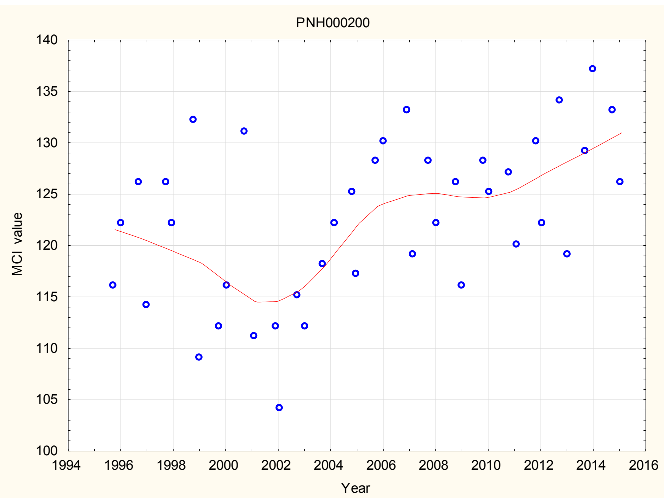
Prior to the current 2014-2015 period, 25 taxa have characterised the community at this site on occasions. These have comprised eight 'highly sensitive', ten 'moderately sensitive', and seven 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the (upper) mid reaches of a ringplain stream. Predominant taxa have included three 'highly sensitive' taxa [mayflies (*Deleatidium* on every occasion, and *Nesameletus*) and stonefly (*Zelandoperla*)]; four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles (on very occasion), stony-cased caddisfly (*Pycnocentrodes*), and free-living caddisfly (*Costachorema*)]; and two 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and orthoclad midges]. Five of these predominant taxa were dominant in the spring, 2014 community while the summer, 2015 community was characterised by all but one of the taxa dominant in spring together with an additional three 'moderately sensitive' and three 'tolerant' taxa. All but four of these taxa previously had been predominantly characteristic of this site's communities (Table 51). Despite these seasonal taxa differences, minimal significant differences in numerical dominances between seasons were reflected in the identical seasonal high $SQMCI_s$ scores (7.9 units) (Tables 150 and 151). All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 74% 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 seven units above the distance predictive value. The spring, 2014 survey score (133 units) was significantly (Stark, 1998) higher than both predictive values while the summer, 2015 score (126 units) was also significantly higher (by 14 units) than the altitude predictive value and 11 units above the distance predictive value. Of the 40 surveys to date at this site, only 8% of MCI scores have been less than 112 units while 80% have been greater than 115 units.

#### 3.2.13.1.4 Temporal trends 1995 to 2015

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.338
p level = 0.002 [>FDR, p = 0.005]
Significant at p < 0.01 level; and after FDR at p < 0.01

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

A steady increase in MCI scores had been apparent between 2002 and 2007, and again since 2010, resulting in the positive trend in scores over the entire period which has been statistically significant after FDR (at p<0.01 level). The range of LOWESS-smoothed scores (16 units) has been of ecological importance, particularly since 2002 (coincident with localised riparian fencing and planting of the true left-bank of the stream). Overall, smoothed MCI scores were indicative of 'good' generic stream health (Table 1) until 2001 improving to 'very good' health after 2004 where it remains.

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

### 3.2.13.2 SH 45 site (PNH000900)

#### 3.2.13.2.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken at this lower reach site at SH 45 in the Punehu Stream between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| PNH000900 | 38 | 10-26 | 21 | 70-106 | 88 | 20 | 114 | 22 | 99 |

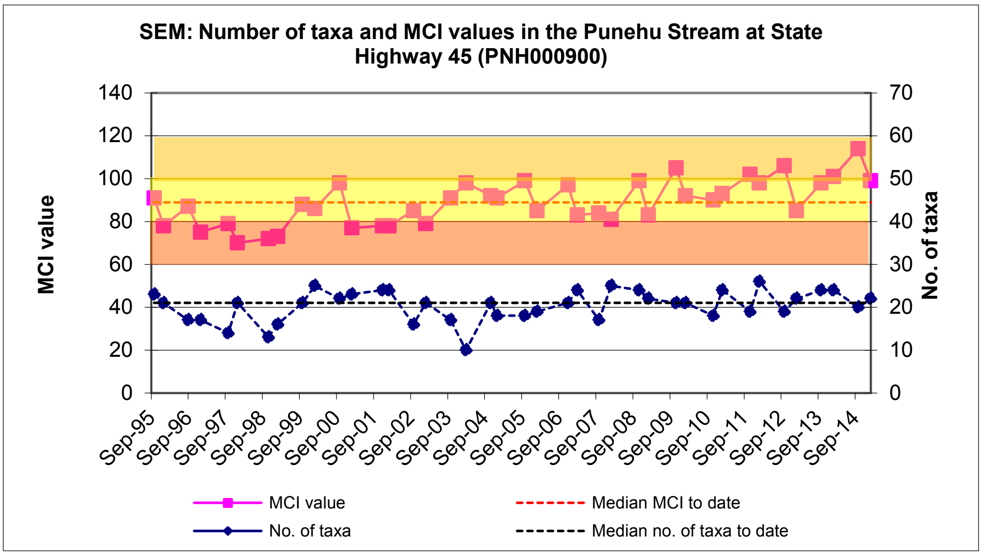



**Figure 48** Numbers of taxa and MCI values in the Punehu Stream at SH 45

A wide of richnesses (10 to 26 taxa) has been found with a median richness of 21 taxa, relatively typical of richnesses in the lower reaches of ringplain streams and rivers. During the 2014-2015 period, spring (20 taxa) and summer (22 taxa) richnesses were similar and within one taxon of the median taxa number coincident with increased patchy filamentous algal substrate cover and higher water temperature at the time of the summer survey.

MCI scores have had a relatively wide range (36 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (88 units) also has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (114 units) score was far higher than typical for such a site and above the historical maximum by eight units and the median by a significant 26 units. The summer 2015 score (99 units) was also higher than typical for such a site and a significant 11 units above the historical median value. 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 (88 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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| ANNELIDA | Oligochaeta | 1 | 30 | 79 | | |
| MOLLUSCA | *Potamopyrgus* | 4 | 21 | 55 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 3 | 8 | A | A |
| | *Coloburiscus* | 7 | 5 | 13 | VA | A |
| | *Deleatidium* | 8 | 16 | 42 | XA | XA |
| PLECOPTERA | *Acroperla* | 5 | 1 | 3 | | |
| | *Zelandobius* | 5 | 0 | 0 | A | |
| COLEOPTERA | Elmidae | 6 | 26 | 68 | | |
| MEGALOPTERA | *Archichauliodes* | 7 | 8 | 21 | A | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 19 | 50 | A | VA |
| | *Hydrobiosis* | 5 | 16 | 42 | | |
| | *Beraeoptera* | 8 | 1 | 3 | A | |
| | *Oxyethira* | 2 | 4 | 11 | | |
| | *Pycnocentrodes* | 5 | 15 | 39 | VA | A |
| DIPTERA | *Aphrophila* | 5 | 18 | 47 | | |
| | *Maoridiamesa* | 3 | 18 | 47 | | |
| | Orthocladiinae | 2 | 33 | 87 | | |
| | *Polypedilum* | 3 | 0 | 0 | | VA |
| | Tanytarsini | 3 | 10 | 26 | | |
| | Ceratopogonidae | 3 | 1 | 3 | | |
| | Empididae | 3 | 6 | 16 | | |
| | Muscidae | 3 | 2 | 5 | | |
| | *Austrosimulium* | 3 | 4 | 11 | | A |

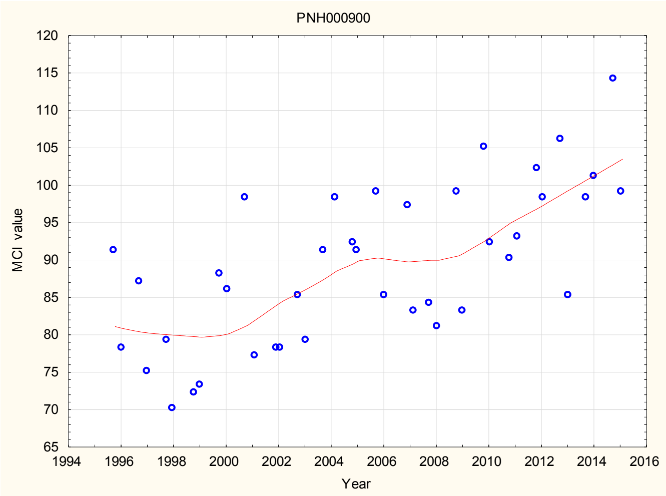
Prior to the current 2014-2015 period 21 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', nine 'moderately sensitive', and eleven 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa as might be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly sensitive' taxa; one 'moderately sensitive' taxon [elmid beetles], and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges]. Seven of the historically characteristic taxa, one of which had been predominant, were dominant in the spring 2014 community together with one taxon ['moderately sensitive' stonefly (*Zelandobius*)] not previously characteristic at this site. These were comprised of two 'highly sensitive', five 'moderately sensitive', and one 'tolerant' taxa, whereas six of these taxa and two additional 'tolerant' taxa (one of which [midge (*Polypedilum)*] had previously not been characteristic at this site) were dominant in summer 2015. These were comprised of one 'highly sensitive', four 'moderately sensitive', and three 'tolerant' taxa. Six of these ten taxa were dominant in both spring and summer communities (Table 53). An increase in the proportional dominance by 'tolerant' taxa and decrease in numerical abundances within three 'sensitive' taxa, caused a relatively small decrease in summer $SQMCI_s$ score of 0.7 unit (Tables 150 and 151). The five taxa recorded as very or extremely abundant during spring and summer had characterised this site's communities on 0% to 50% of past survey occasions.

#### 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 (88 units) was only two units above the altitude prediction and an insignificant (Stark, 1998) 10 units lower than the distance predictive value. The spring, 2014 survey score (114 units) was a significant 16 to 28 units above these predictive values and the summer, 2015 score (99 units) was from one to a significant 13 units above predictive values. Of the 40 surveys to date at this site, 33% of MCI scores have been less than 86 units while only 25% have been greater than 98 units.

#### 3.2.13.2.4 Temporal trends in 1995 to 2015

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006), has been performed on the twenty 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 = 40
Kendall tau = +0.490
p level < 0.0001 [>FDR, p < 0.001]
Significant at p <0.05 and p < 0.01;
and after FDR.

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

This site's MCI scores have shown a strong positive temporal trend over the twenty year period which was statistically significant (p<0.01) after FDR application.

The LOWESS-smoothed MCI scores' wide range (24 units) has been ecologically important over this period with scores mainly indicative of 'poor' generic stream health (Table 1) prior to early 1999 improving to 'fair' health throughout most of the subsequent period and to 'good' health more recently. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, stream health improved from 'worse than expected' very early in the period to the 'expected' category throughout the remainder of the period although issues have occurred on occasions with consented dairy shed discharge compliance and cumulative impacts of such discharges in the Mangatawa Stream sub-catchment in the local vicinity of the site (TRC, 2011 and Fowles, 2014).

### 3.2.13.3 Discussion

Seasonal MCI values typically decreased between spring and summer at the upper mid-reach (Wiremu Road) site by seven units which was very similar to the historical median seasonal difference for this site (Appendix II). Another typical but larger decrease (15 units) was found at the lower reach site (SH 45) in comparison with the historical seasonal median decrease of eight units (Appendix II). Seasonal communities at the upper mid reach site shared 17 common taxa (59% of the 29 taxa found at this site in 2014-2015) compared with 14 shared common taxa (50% of the 28 taxa found in 2014-2015) 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 (48% of the 27 taxa) in spring and 14 common taxa (41% of 34 taxa) in summer, indicative of the dissimilarity in spatial community structures and to a greater degree in summer.

MCI score typically fell in a downstream direction in both spring (by 19 units) and typically more markedly in summer (by 27 units), over a stream distance of 16.5 km through the (upper) mid to lower reaches of this stream. These falls in MCI scores equated to average rates of decline of 1.2 units/km in spring increasing to 1.6 units/km in summer, compared with a predicted average rate of 1.0 unit/km over the equivalent length of a National Park-sourced stream (Stark and Fowles, 2009) indicative of additional impacts from 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 average rate of decline has been 2.0 MCI units/km over the surveyed length. Therefore average rates of decline over the 2014-2015 period were lower in both spring and summer than the historical average median rate.

## 3.2.14 Patea River

The results of spring (2014) and summer (2014-2015) 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-eight surveys have been undertaken at this upper reach, shaded site adjacent to the National Park boundary in the Patea River between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Nov 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| PAT000200 | 38 | 24-35 | 31 | 127-145 | 138 | 33 | 138 | 30 | 138 |

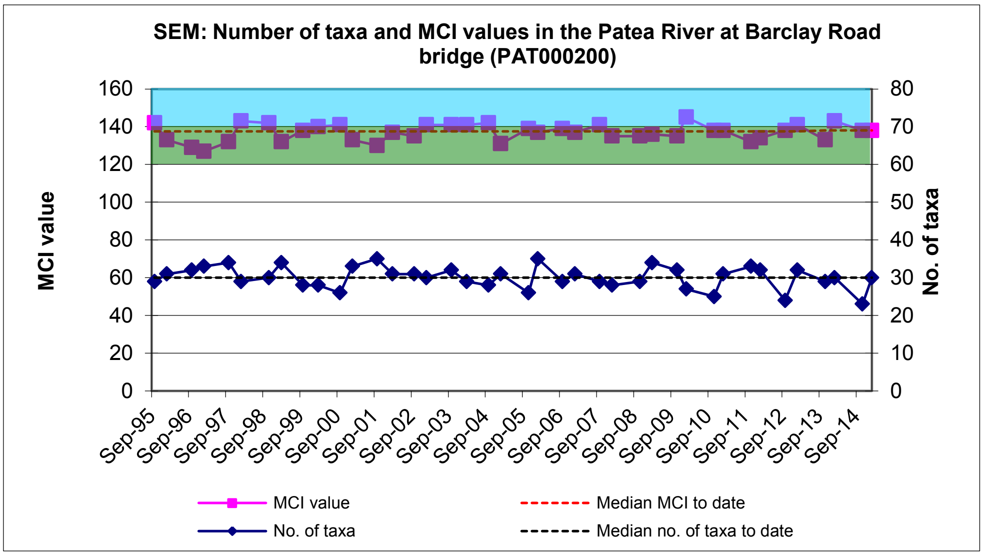



**Figure 50** Numbers of taxa and MCI values in the Patea River at Barclay Road

A moderate range of richnesses (24 to 35 taxa) has been found with a relatively high median richness of 31 taxa, typical of richnesses in ringplain streams and rivers near the National Park boundary. During the 2014-2015 period spring richness (23 taxa) was markedly lower than the historical median and one taxon fewer than the previous minimum richness. The higher summer richness (30 taxa) was within one taxon of this median richness. This was coincident with very thin periphyton mat layers on the predominantly stony-bouldery substrate of this shaded site on both survey occasions.

MCI values have had a moderate range (18 units) at this site, more typical of a National Park boundary site. The high median value (138 units) has been typical of upper reach sites elsewhere on the ringplain (TRC, 2015a) and the spring, 2014 (138 units) and summer, 2015 (138 units) scores continued this trend for such a site. Both seasonal scores were equivalent to the historical median score.

They categorised this site as having 'very good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health for the upper reaches of a ringplain stream in spring and summer respectively. The historical median score (138 units) placed this site in the 'very good' and '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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| EPHEMEROPTERA | *Austroclima* | 7 | 7 | 18 | | A |
| | *Coloburiscus* | 7 | 38 | 100 | VA | VA |
| | *Deleatidium* | 8 | 38 | 100 | XA | XA |
| | *Nesameletus* | 9 | 6 | 16 | | |
| PLECOPTERA | *Acroperla* | 5 | 1 | 3 | | |
| | *Austroperla* | 9 | 1 | 3 | | |
| | *Megaleptoperla* | 9 | 15 | 39 | | |
| | *Zelandobius* | 5 | 14 | 37 | A | |
| | *Zelandoperla* | 8 | 30 | 79 | A | A |
| COLEOPTERA | Elmidae | 6 | 33 | 87 | | A |
| | Hydraenidae | 8 | 12 | 32 | | |
| MEGALOPTERA | *Archichauliodes* | 7 | 7 | 18 | | |
| TRICHOPTERA | *Costachorema* | 7 | 2 | 5 | | |
| | *Hydrobiosis* | 5 | 1 | 3 | | |
| | *Hydrobiosella* | 9 | 2 | 5 | | |
| | *Hydropsyche (Orthopsyche)* | 9 | 27 | 71 | | |
| | *Beraeoptera* | 8 | 18 | 47 | A | |
| | *Helicopsyche* | 10 | 14 | 37 | | |
| | *Olinga* | 9 | 1 | 3 | | |
| | *Zelolessica* | 7 | 1 | 3 | | |
| DIPTERA | *Aphrophila* | 5 | 35 | 92 | A | A |
| | Orthocladiinae | 2 | 16 | 42 | | |
| | *Polypedilum* | 3 | 2 | 5 | | A |

Prior to the current 2014-2015 period, 23 taxa had characterised the community at this site on occasions. These have comprised eleven 'highly sensitive', ten 'moderately sensitive', and only two 'tolerant' taxa i.e. a majority of 'highly sensitive' taxa as would be expected near the National Park boundary of a ringplain river. Predominant taxa have included three 'highly sensitive' taxa [mayfly (*Deleatidium* on every sampling occasion), stonefly (*Zelandoperla*), and caddisfly (*Hydropsyche-*

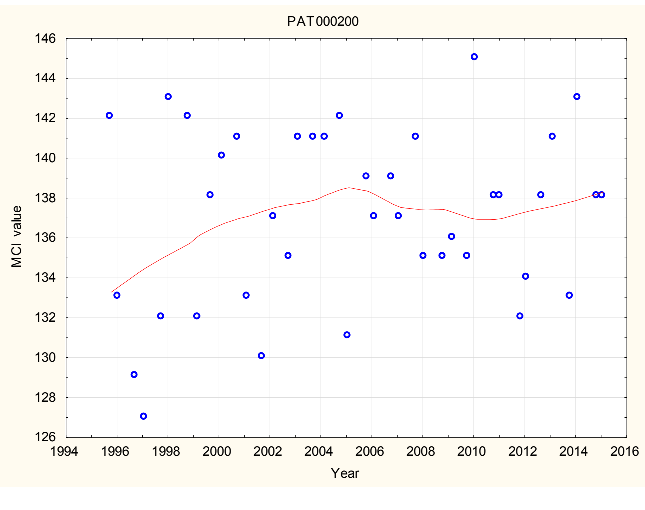
*Orthopsyche*)]; three 'moderately sensitive' taxa [mayfly (*Coloburiscus* on every occasion), elmid beetles, and cranefly (*Aphrophila*)]; but no 'tolerant' taxa. Six of the characteristic taxa were dominant in the spring, 2014 community, four of which were predominant taxa. Four of these taxa again were dominant in the summer, 2015 community together with two additional 'moderately sensitive' and one 'tolerant' taxa, all of which have been historically characteristic of this site. Two other 'sensitive' taxa which had been dominant in spring were not characteristic taxa of the community in summer. Despite some variability amongst the 'highly' and 'moderately' sensitive taxa dominances, the numerical dominance by two taxa in both seasons resulted in seasonal $SQMCI_s$ values which were within 0.1 unit (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 (138 units) is only 3 units higher than the altitude prediction but a significant 13 units above the distance predictive value. The spring, 2014 score (138 units) and summer, 2015 score (138 units) were three to a significant 13 units higher than these predictive values. Of the 40 surveys to date at this site, no MCI scores have been less than 125 units while 65% have been greater than 135 units.

### 3.2.14.1.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.069
p value = 0.531 [>FDR, p = 0.617]
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 twenty year monitoring period during which there has been a minimal overall trend of slight improvement. Neither has the range of LOWESS-smoothed scores (five units) shown ecological importance. 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 remained in the 'expected' category throughout the period.

### 3.2.14.2 Swansea Road site (PAT000315)

#### 3.2.14.2.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Patea River at this mid-reach site at Swansea Road, Stratford between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Nov 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| PAT000315 | 38 | 20-32 | 26 | 99-130 | 110 | 21 | 124 | 29 | 110 |

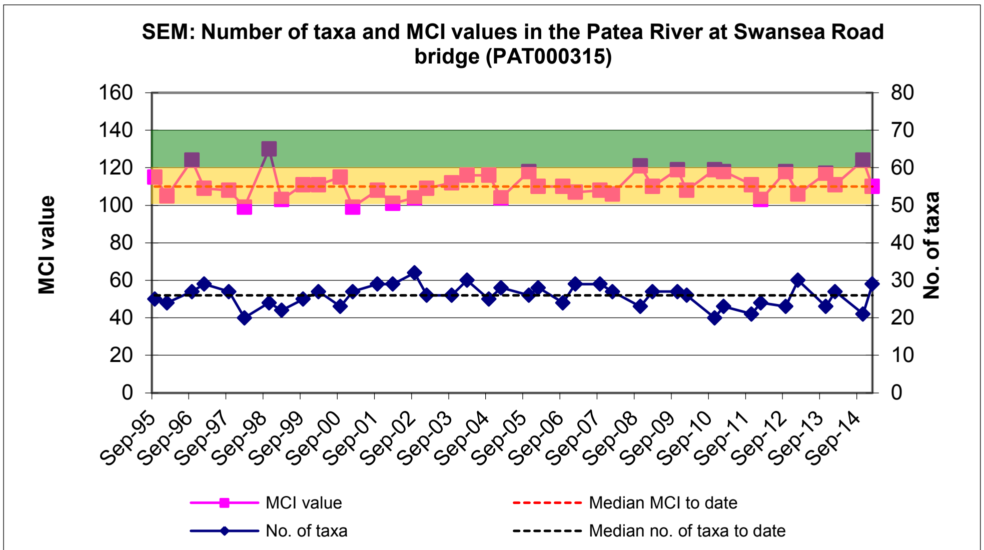



**Figure 52** Numbers of taxa and MCI values in the Patea River at Swansea Road

A moderate range of richnesses (20 to 32 taxa) has been found, with a median richness of 26 taxa, typical of richnesses in the mid reaches of ringplain streams and rivers. During the 2014-2015 period, spring (21 taxa) and summer (29 taxa) richnesses were different; well below the median taxa number in spring coincident with minimal substrate periphyton cover, and three taxa above the median in summer when periphyton substrate cover by filamentous algae increased to patchy.

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, 2014 (124 units) and summer, 2015 (110 units) scores significantly different and 14 units above and equivalent with the historical median respectively. This spring score was the third highest MCI value recorded to date. These scores categorised this site as having 'very good' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' (spring) and 'expected' (summer) health for the mid reaches of a ringplain river. The historical median score (110 units) placed this site in the 'good' and '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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| ANNELIDA | Oligochaeta | 1 | 8 | 21 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 13 | 34 | | |
| | *Coloburiscus* | 7 | 38 | 100 | XA | XA |
| | *Deleatidium* | 8 | 31 | 82 | XA | XA |
| | *Nesameletus* | 9 | 15 | 39 | | A |
| PLECOPTERA | *Acroperla* | 5 | 4 | 11 | | |
| | *Zelandoperla* | 8 | 11 | 29 | | |
| COLEOPTERA | Elmidae | 6 | 24 | 63 | | VA |
| | Hydraenidae | 8 | 7 | 18 | | A |
| MEGALOPTERA | *Archichauliodes* | 7 | 15 | 39 | A | VA |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 27 | 71 | | XA |
| | *Costachorema* | 7 | 20 | 53 | A | |
| | *Hydrobiosis* | 5 | 5 | 13 | | |
| | *Neurochorema* | 6 | 4 | 11 | | |
| | *Beraeoptera* | 8 | 8 | 21 | | |
| | *Pycnocentrodes* | 5 | 4 | 11 | | |
| DIPTERA | *Aphrophila* | 5 | 33 | 87 | A | VA |
| | Eriopterini | 5 | 1 | 3 | | |
| | *Maoridiamesa* | 3 | 25 | 66 | | |
| | Orthocladiinae | 2 | 33 | 87 | A | A |
| | Tanytarsini | 3 | 10 | 26 | | |
| | Muscidae | 3 | 2 | 5 | | |
| | *Austrosimulium* | 3 | 10 | 26 | | |

Prior to the current 2014-2015 period, 23 taxa had characterised the community at this site on occasions. These have comprised five 'highly sensitive', eleven 'moderately sensitive', and seven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increase in 'tolerant' taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Costachorema*), and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche- Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)]. Six of these historically characteristic taxa (five predominant taxa) were dominant in the spring 2014 community. These comprised one 'highly sensitive' taxon, four 'moderately sensitive' taxa, and one 'tolerant' taxon, whereas three 'highly sensitive', four '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). An increased numerical dominance by one 'tolerant' taxon in particular was reflected in the decrease of 1.1 units in $SQMCI_s$ score in summer (Tables 152 and 153).

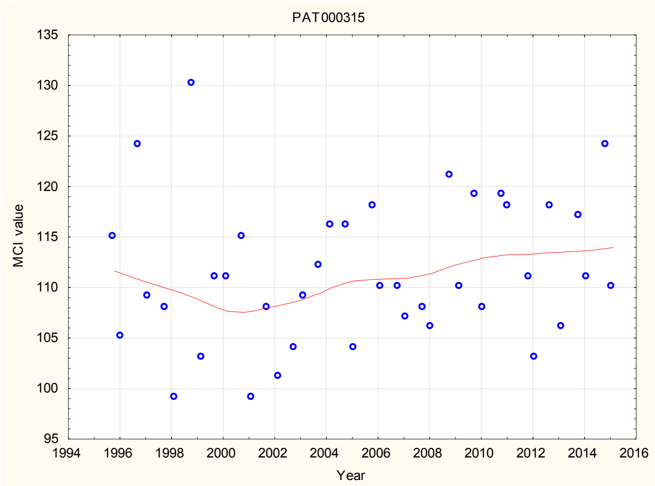
The six taxa found as very and/or extremely abundant by the seasonal surveys have characterised this site's communities on 39% to 100% of past survey occasions.

#### 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 five units lower than the altitude prediction and seven units higher than the distance predictive value while the spring, 2014 survey score (124 units) was nine units higher than the predictive altitude value but a significant 21 units higher than the predictive distance value. The summer, 2015 score (110 units) was five units below the predictive altitude value but seven units above the predictive distance value. Of the 40 surveys to date at this site, only 8% of MCI scores have been less than 103 units while 30% have been greater than 115 units.

#### 3.2.14.2.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.154
p value = 0.161 [>FDR, p = 0.239]
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 twenty year period. The range of LOWESS-smoothed scores (six units) was of no ecological importance. 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 in the 'expected' category for the entire period.

### 3.2.14.3 Skinner Road site (PAT000360)

#### 3.2.14.3.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Patea River at this mid-reach site at Skinner Road (some 6 km downstream of the Swansea Road, Stratford site), between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Nov 2013 | | Feb 2014 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| PAT000360 | 38 | 15-33 | 24 | 86-105 | 98 | 28 | 101 | 23 | 101 |

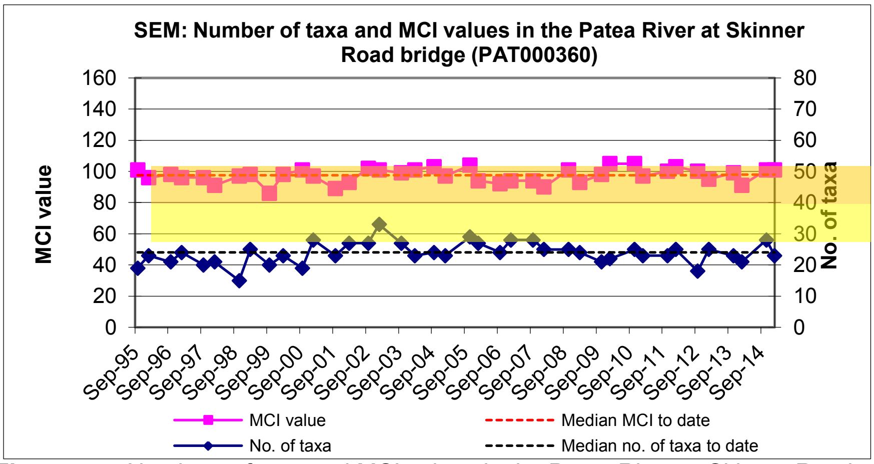



**Figure 54** Numbers of taxa and MCI values in the Patea River at Skinner Road

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 2014-2015 period spring (28 taxa) and summer (23 taxa) richnesses were relatively similar and four taxa higher than the median taxa number in spring and one taxon below median richness in summer when substrate periphyton cover was more widespread.

MCI values have had a moderate range (19 units) at this site, typical of sites in the mid-reaches of ringplain streams and rivers. The median value (98 units) has been relatively typical of the scores at mid-reach sites elsewhere on the ringplain however (TRC, 2015a). The spring, 2014 (101 units) and summer, 2015 (101 units) scores were identical and typical of scores for such a site. They were both three units higher than the historical median and categorised this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health in spring and summer for the mid-reaches of a ringplain river. The historical median score (98 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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 5 | 13 | | |
| **ANNELIDA** | Oligochaeta | 1 | 25 | 66 | A | VA |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 10 | 26 | | |
| **CRUSTACEA** | *Paracalliope* | 5 | 1 | 3 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 1 | 3 | | |
| | *Coloburiscus* | 7 | 12 | 32 | VA | A |
| | *Deleatidium* | 8 | 17 | 45 | XA | A |
| **PLECOPTERA** | *Acroperla* | 5 | 2 | 5 | | |
| **COLEOPTERA** | Elmidae | 6 | 30 | 79 | VA | A |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 17 | 45 | A | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 31 | 82 | VA | VA |
| | *Costachorema* | 7 | 12 | 32 | A | |
| | *Hydrobiosis* | 5 | 19 | 50 | | A |
| | *Oxyethira* | 2 | 4 | 11 | | |
| | *Pycnocentrodes* | 5 | 9 | 24 | | |
| **DIPTERA** | *Aphrophila* | 5 | 29 | 76 | VA | A |
| | *Maoridiamesa* | 3 | 31 | 82 | VA | VA |
| | Orthocladiinae | 2 | 38 | 100 | VA | VA |
| | Tanytarsini | 3 | 18 | 47 | A | VA |
| | Empididae | 3 | 2 | 5 | | |
| | Muscidae | 3 | 8 | 21 | | |
| | *Austrosimulium* | 3 | 8 | 21 | | |

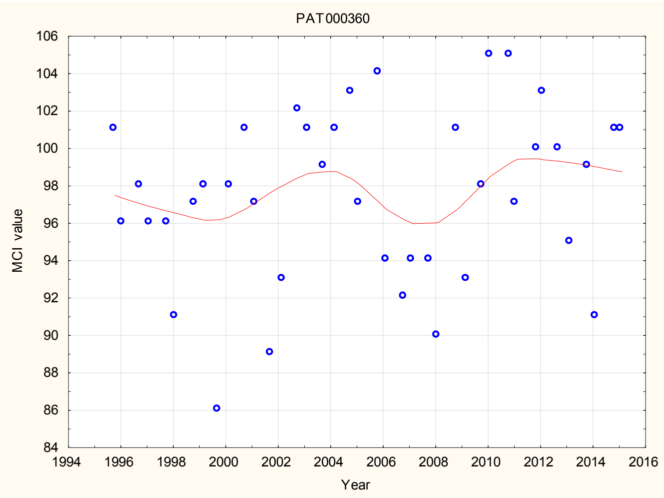
Prior to the current 2014-2015 period, 22 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive' taxon, but ten 'moderately sensitive' and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportions of 'moderately sensitive' and 'tolerant' taxa as would be expected in the mid-reaches of a ringplain river. Predominant taxa have included no 'highly sensitive' taxa, three 'moderately sensitive' taxa [elmid beetles, free-living caddisfly (*Hydrobiosis*), and cranefly (*Aphrophila*)], and four 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. Eleven of the historically characteristic taxa (six of the predominant taxa) were dominant in the spring, 2014 community. These comprised one 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa, whereas one 'highly sensitive', four 'moderately sensitive', and five 'tolerant' taxa comprised the dominant taxa of the summer, 2015 community. Nine of these twelve taxa were dominant in both spring and summer communities (Table 61). A more typical increase in summer numerical dominance within two 'tolerant' taxa and decrease in the abundance of the single characteristic 'highly sensitive' mayfly (in particular), and two 'moderately sensitive' taxa, were reflected in the decrease of 2.5 units in $SQMCI_s$ scores between spring and summer (Tables 152 and 153). The nine taxa found as very and/or extremely abundant by the seasonal surveys have characterised this site's communities on 32% to 100% of past survey occasions.

#### 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 (98) is a significant (Stark, 1998) 11 units lower than the altitude prediction but only one unit lower than the distance predictive value. The spring, 2014 and summer 2015 surveys' scores (101 units) were eight units lower than the altitude predictive value and two units above the predicted distance value. Of the 40 surveys to date at this site, 58% of MCI scores have been less than 99 units while no scores have been greater than 109 units, indicative of some acceleration in deterioration in river 'health' through the reach below Swansea Road (in the township), by comparison with the historical record at this nearest upstream site.

#### 3.2.14.3.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.144
p value = 0.191 [>FDR, p = 0.276]
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 twenty year period has not been statistically significant. An apparent decline in scores between 2004 and 2008 has been followed by some improvement followed by a more recent plateau in scores. The very small range of LOWESS-smoothed scores (three units) has had no ecological importance over the period. Smoothed MCI scores consistently indicated 'fair' generic river health (Table 1) briefly bordering on 'good' health eight and four years ago. 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 twenty year period, briefly bordering on 'worse than expected' in 1999 and 2007-2008.

### 3.2.14.4 Discussion

Seasonal MCI values atypically remained the same between spring and summer at two sites (Barclay and Skinner Roads) while at the Swansea Road site, a more typical summer decrease in MCI score (14 units) was recorded. This was six units higher than the historical median seasonal difference for this site (Appendix II). Seasonal communities shared 56% of the 34 taxa at the upper site, 61% of 31 taxa at Swansea Road, and 65% of 31 taxa at the furthest downstream site in the middle reaches indicative of an atypical greater seasonal community composition dissimilarity at the site in the upper reaches of the river despite no change in seasonal MCI score at this site.

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

Between the upper reach site and Swansea Road mid-reach site, the spring (1.3 units/km) and summer (2.5 units/km) average rates of decline were less than (spring) and higher than (summer) the predicted average rate (2.0 units/km) for the equivalent river reach. For the Swansea Road mid-reach to Skinner Road mid-reach sites, the spring (3.7 units/km) rate of decline was well above the predicted average rate of 0.6 unit/km, but atypically there was a lower rate of decline (1.7 units/km) in summer.

Using the long-term median SEM MCI scores for each site (Appendix II), the average 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 1.9 units per km respectively with an overall median average rate of decline of 2.3 MCI units/km over the surveyed length. Therefore average rates of MCI decline in the 2014-2015 period were generally relatively similar to median average rates for the 1995 to 2014 period for the various surveyed reaches of the river, with the exception of the high spring 2014 average rate through the mid reaches of the river.

Community composition varied markedly through the upper to mid-reach length of the river surveyed. A total of 39 taxa was recorded in spring of which only 11 taxa (28%) were present at all three sites. These included three 'highly sensitive', six '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 higher total of 44 taxa was found along the river's length by the summer survey of which only 12 taxa (27%) were present at all three sites. These were relatively similar to the widespread taxa in spring with the loss of one 'highly sensitive' taxon and addition of two 'moderately sensitive' taxa. Only the one 'highly sensitive' mayfly taxon and three 'moderately sensitive' taxa were abundant at all three sites in summer. These dissimilarities in spatial community structure along the surveyed length (upper to mid-reaches) of the Patea River were much less pronounced between seasons than typical in the past.

## 3.2.15 Mangaehu River

The results found by the 2014-2015 surveys are presented in Table 154 and Table 155 Appendix I for this single site in the lower reaches of a large hill country river.

### 3.2.15.1 Raupuha Road site (MGH000950)

#### 3.2.15.1.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken at this lower reach site in the Mangaehu River between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Nov 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MGH000950 | 38 | 13-26 | 19 | 77-104 | 91 | 22 | 103 | 22 | 98 |

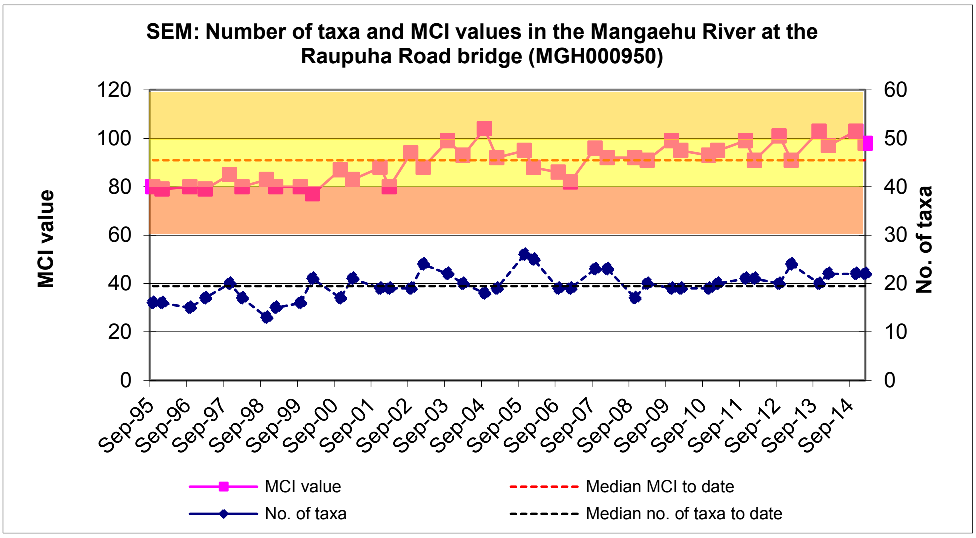



**Figure 56** Numbers of taxa and MCI values in the Mangaehu River at Raupuha Road

A relatively wide range of richnesses (13 to 26 taxa) has been found with a moderate median richness of 19 taxa (slightly above typical richnesses in the lower reaches of hill country rivers, although generally at lower altitudes (TRC, 2015a)). During the 2014-2015 period, spring (22 taxa) and summer (22 taxa) richnesses were equal despite more widespread summer substrate periphyton cover, and slightly higher than the historical median richness.

MCI values have had a relatively wide range (27 units) at this site more typical of a site in the lower reaches of streams and rivers. The median value (91 units) has been typical of lower reach sites elsewhere and two units less than the median score (93 units) recorded by 55 previous surveys at 'control' sites located at similar altitudes (to the Raupuha Road site) in hill country rivers and streams (TRC, 2015a). The spring, 2014 (103 units) and summer, 2015 (98 units) scores showed a typical summer decrease and were seven to a significant 12 units higher than the historical median.

These scores categorised this site as having 'good' and 'fair' health generically (Table 1) in spring and summer respectively.

The historical median score (91 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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 1 | 3 | | |
| **ANNELIDA** | Oligochaeta | 1 | 4 | 11 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 10 | 26 | | |
| **CRUSTACEA** | *Paracalliope* | 5 | 5 | 13 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 10 | 26 | VA | VA |
| | *Coloburiscus* | 7 | 2 | 5 | | A |
| | *Deleatidium* | 8 | 5 | 13 | A | |
| | *Mauiulus* | 5 | 1 | 3 | | |
| | *Zephlebia group* | 7 | 4 | 11 | | |
| **PLECOPTERA** | *Acroperla* | 5 | 8 | 21 | | |
| **COLEOPTERA** | Elmidae | 6 | 4 | 11 | | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 21 | 55 | A | VA |
| | *Costachorema* | 7 | 7 | 18 | A | |
| | *Hydrobiosis* | 5 | 17 | 45 | A | A |
| | *Oxyethira* | 2 | 2 | 5 | | |
| | *Pycnocentrodes* | 5 | 16 | 42 | VA | A |
| **DIPTERA** | *Aphrophila* | 5 | 30 | 79 | A | A |
| | *Maoridiamesa* | 3 | 26 | 68 | VA | A |
| | Orthocladiinae | 2 | 36 | 95 | A | A |
| | Tanytarsini | 3 | 16 | 42 | A | A |
| | Empididae | 3 | 4 | 11 | | |
| | Muscidae | 3 | 7 | 18 | | |
| | *Austrosimulium* | 3 | 6 | 16 | | |

Prior to the current 2014-2015 period, 23 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', eleven 'moderately sensitive', and 11 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as would be expected in the lower reaches of an eastern hill-country river. Predominant taxa have included only one 'moderately sensitive' taxon [cranefly (*Aphrophila*)] and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)]. All four of these predominant taxa were dominant in the spring, 2014 community together with six other historically characteristic (one 'highly sensitive', four 'moderately sensitive', and one 'tolerant') taxa. The summer, 2015 community was characterised by eight of the taxa dominant in spring, one additional 'moderately sensitive' taxon, and two fewer 'sensitive' taxa (Table 61). Despite these seasonal differences in characteristic taxa, there was only a minimal difference of 0.1 unit in the seasonal $SQMCI_s$ scores (Tables 154 and 155).

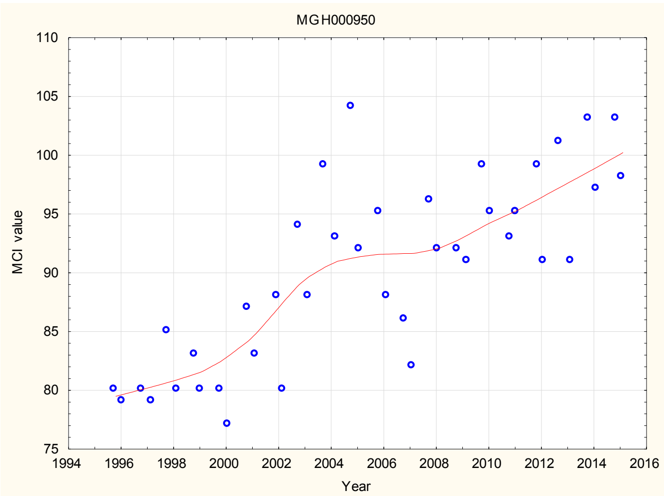
Those taxa recorded as very abundant during spring and/or summer surveys had been characteristic of this site's communities on 26 to 68% of past survey occasions.

#### 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 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty years 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 = 40
Kendall tau = +0.587
p value < 0.0001 [>FDR, p < 0.0001]
Significant at p<0.05 and p<0.01; and after FDR.

**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 reach, hill country river 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 between in 2004 and 2008 before improving steadily again since then. The wide range of LOWESS-smoothed MCI scores (20 units) has also been ecologically important, particularly over the period since 2000.

Smoothed MCI scores originally bordering on 'poor/fair' generic river health (Table 1) have trended upward to 'fair' approaching 'good' health very recently (Figure 57).

#### 3.2.15.2 Discussion

Seasonal MCI values typically decreased (by 5 units) between spring and summer at this lower reach site, and by a similar amount to the median four unit seasonal difference found to date (Appendix II), with the percentage community composition of 'tolerant' taxa increasing by 9% at the time of the summer survey. Seasonal communities at this site shared 17 common taxa (63% of the 27 taxa found at this site in 2014-2015), a moderate percentage of common taxa, accounting for the relatively small dissimilarity in seasonal MCI values.

## 3.2.16 Waingongoro River

The results of spring (2014 ) and summer (2014-2015) surveys are summarised in Table 156 and Table 157, Appendix I.

### 3.2.16.1 Site near National Park boundary (WGG000115)

#### 3.2.16.1.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken at this upper reach site, 700m downstream of the National Park boundary in the Waingongoro River, between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WGG000115 | 38 | 24-40 | 32 | 122-139 | 132 | 30 | 125 | 28 | 139 |

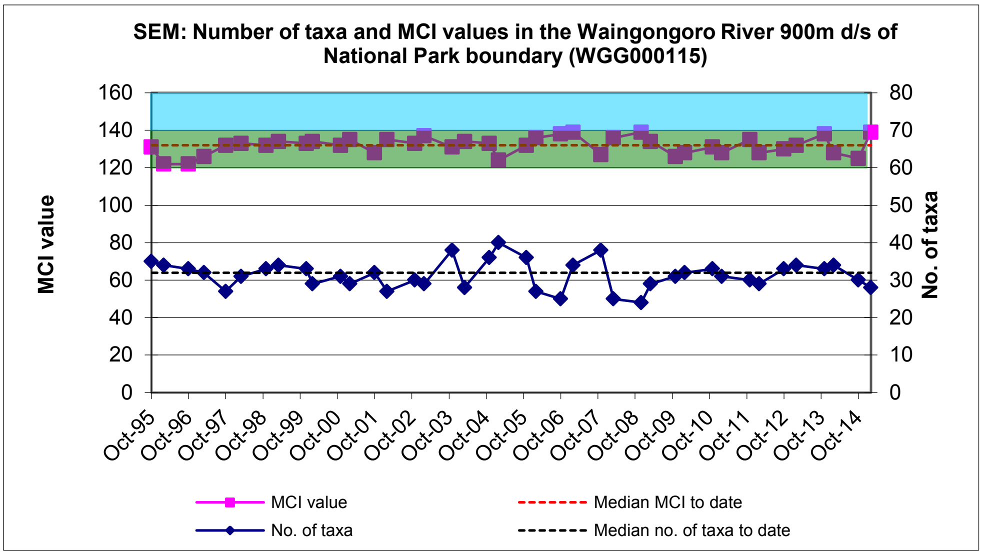



**Figure 58** Numbers of taxa and MCI values in the Waingongoro River 700 m d/s National Park

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 2014-2015 period, spring (30 taxa) and summer (28 taxa) richnesses were similar and slightly less than the median taxa number.

MCI values have had a moderate range (17 units) at this site, more typical of a National Park boundary site. The median value (132 units) also has been typical of upper reach sites elsewhere on the ringplain (TRC, 2015a) and the spring, 2014 (125 units) and summer, 2015 (139 units) scores although dissimilar, were within seven units of the historical median. They categorised this site as having 'very good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'worse than expected' (spring) and 'expected' (summer) health for the upper reaches of a ringplain stream. The historical median score (132 units) placed this site in the 'very good' and 'expected' categories for generic and predictive methods of assessment respectively.

### 3.2.16.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| EPHEMEROPTERA | *Austroclima* | 7 | 23 | 61 | | A |
| | *Coloburiscus* | 7 | 38 | 100 | VA | XA |
| | *Deleatidium* | 8 | 38 | 100 | VA | XA |
| | *Nesameletus* | 9 | 20 | 53 | A | A |
| PLECOPTERA | *Acroperla* | 5 | 3 | 8 | | |
| | *Austroperla* | 9 | 3 | 8 | | |
| | *Megaleptoperla* | 9 | 35 | 92 | | A |
| | *Stenoperla* | 10 | 3 | 8 | | |
| | *Zelandobius* | 5 | 2 | 5 | | |
| | *Zelandoperla* | 8 | 38 | 100 | VA | VA |
| COLEOPTERA | Elmidae | 6 | 38 | 100 | A | A |
| | Hydraenidae | 8 | 25 | 66 | | A |
| MEGALOPTERA | *Archichauliodes* | 7 | 7 | 18 | | |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 35 | 92 | A | |
| | *Beraeoptera* | 8 | 30 | 79 | A | |
| | *Helicopsyche* | 10 | 20 | 53 | A | |
| | *Olinga* | 9 | 25 | 66 | | A |
| | *Pycnocentrodes* | 5 | 1 | 3 | | |
| | *Zelolessica* | 7 | 13 | 34 | | |
| DIPTERA | *Aphrophila* | 5 | 38 | 100 | A | VA |
| | *Maoridiamesa* | 3 | 2 | 5 | | |
| | Orthocladiinae | 2 | 18 | 47 | | |

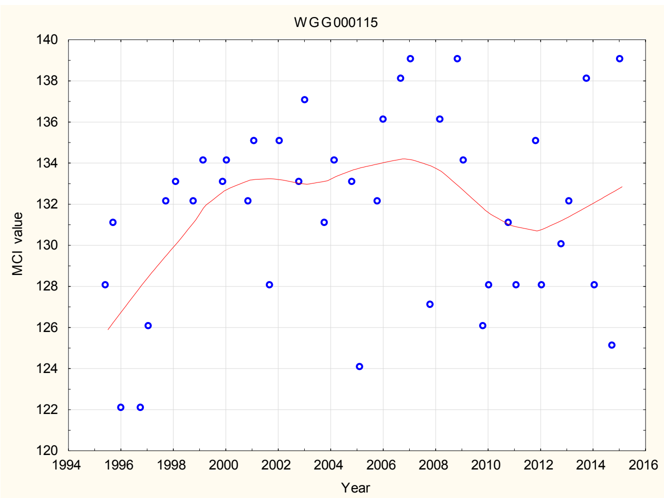
Prior to the current 2014-2015 period, 22 taxa had characterised the community at this site on occasions. These have comprised ten 'highly sensitive', nine 'moderately sensitive', and three 'tolerant' taxa i.e. a high proportion of 'highly sensitive' taxa as might be expected in the upper reaches of a ringplain river near the National Park. Predominant taxa have included eight 'highly sensitive' taxa [mayflies (*Nesameletus* and *Deleatidium*), stoneflies (*Megaleptoperla* and *Zelandoperla*), hydraenid beetles, and cased caddisflies (*Beraeoptera, Helicopsyche,* and *Olinga*)]; four 'moderately sensitive' taxa [mayflies (*Coloburiscus* and *Austroclima*), elmid beetles, and cranefly (*Aphrophila*)]; and only one 'tolerant' taxon [free-living caddisfly (*Hydropsyche-Aoteapsyche*)]. Five of these taxa have been characteristic of communities on every occasion to date. Nine of the historically characteristic taxa (all predominant taxa) were dominant in the spring, 2014 community. These comprised five 'highly sensitive' taxa, three 'moderately sensitive' taxa, and one 'tolerant' taxon, whereas six 'highly sensitive' taxa, four 'moderately sensitive' taxa, but no 'tolerant' taxa comprised the dominant taxa of the summer, 2015 community. Six of these thirteen taxa were dominant in both spring and summer communities, fewer than usually dominant in both seasons at this site. All five taxa dominant on every previous survey occasion were included amongst these six taxa (Table 63). The relatively similar seasonal numerical dominances by high proportions of 'sensitive' taxa were reflected in the very similar seasonal SQMCI$_s$ scores (Tables 156 and 157) which were within 0.1 unit. All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 100% of past survey occasions.

#### 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 132 (distance) for this site. The historical site median (132 units) is 8 units lower than the altitude prediction and equal with the distance predictive value, while the spring, 2014 survey score (125 units) was a significant (Stark, 1998) 15 units lower than the altitude predictive value and seven units less than the distance predictive value, while the summer, 2015 score (139 units) was insignificantly different from both predictive values. Of the 40 surveys to date at this site, 30% 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 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.133
p value = 0.219 [>FDR, p = 0.308]
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 twenty year period. This has not been statistically significant at the 5% level however, although previously (prior to 2008) there had been a statistically significant improvement over the shorter period. After 2007 there was some decline followed by some very recent improvement but the overall range of LOWESS-smoothed MCI scores (eight units) remains less than ecologically important. 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 in the 'expected' category throughout the twenty year period.

### 3.2.16.2 Opunake Road site (WGG000150)

#### 3.2.16.2.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Waingongoro River at this upper mid-reach site at Opunake Road (approximately 7km downstream of the National Park) between October 1995 and February 2014. 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 2014 and summer 2015 results.

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WGG000150 | 38 | 23-39 | 28 | 119-139 | 130 | 28 | 128 | 26 | 123 |

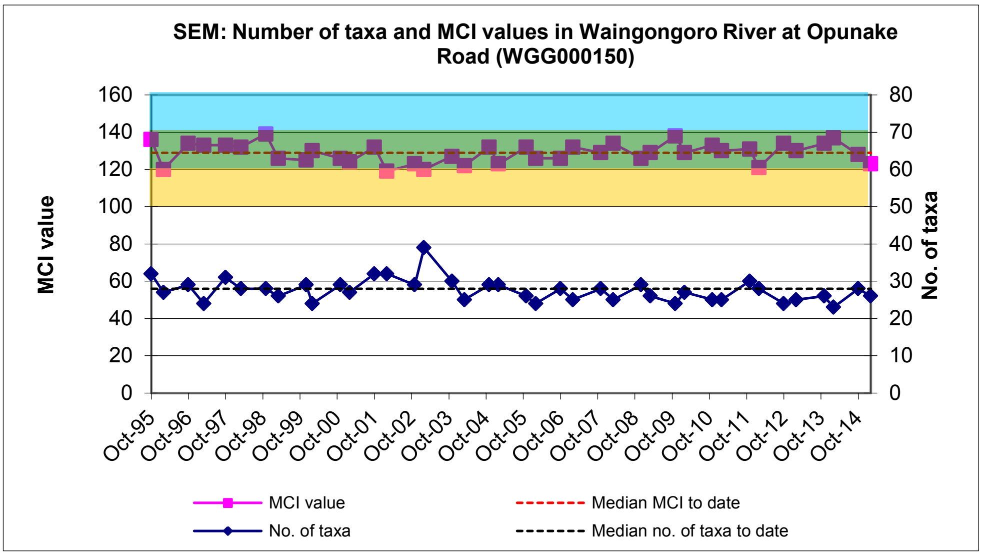



**Figure 60** Numbers of taxa and MCI values in the Waingongoro River at Opunake Road

A relatively wide range of richnesses (23 to 39 taxa) has been found; wider than might be expected, with a median richness of 28 taxa (more representative of typical richnesses in the upper mid reaches of ringplain streams and rivers). During the 2014-2015 period spring (28 taxa) and summer (26 taxa) richnesses were similar and within two taxa of the median taxa number coincidental with minimal substrate periphyton cover (thin mats) 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 (130 units) has been higher typical of upper,mid reach sites elsewhere on the ringplain (TRC, 2015a) however, with the spring, 2014 (128 units) and summer, 2015 (123 units) scores two to seven units below 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' health in spring and 'expected' in summer for the mid reaches of a ringplain river. The historical median score (130 units) placed this site in the 'very good' and 'better than 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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| ANNELIDA | Oligochaeta | 1 | 2 | 5 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 30 | 79 | A | VA |
| | *Coloburiscus* | 7 | 38 | 100 | XA | XA |
| | *Deleatidium* | 8 | 38 | 100 | XA | XA |
| | *Nesameletus* | 9 | 32 | 84 | A | VA |
| PLECOPTERA | *Acroperla* | 5 | 1 | 3 | | |
| | *Megaleptoperla* | 9 | 2 | 5 | | |
| | *Zelandoperla* | 8 | 28 | 74 | VA | |
| COLEOPTERA | Elmidae | 6 | 38 | 100 | A | A |
| | Hydraenidae | 8 | 22 | 58 | A | A |
| MEGALOPTERA | *Archichauliodes* | 7 | 26 | 68 | A | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 32 | 84 | A | VA |
| | *Costachorema* | 7 | 1 | 3 | | |
| | *Hydrobiosis* | 5 | 5 | 13 | | |
| | *Beraeoptera* | 8 | 30 | 79 | VA | |
| | *Confluens* | 5 | 3 | 8 | | |
| | *Helicopsyche* | 10 | 2 | 5 | | |
| | *Olinga* | 9 | 10 | 26 | | |
| | *Pycnocentrodes* | 5 | 14 | 37 | | |
| DIPTERA | *Aphrophila* | 5 | 38 | 100 | A | VA |
| | Eriopterini | 5 | 1 | 3 | | |
| | Orthocladiinae | 2 | 6 | 16 | | |
| | *Polypedilum* | 3 | 0 | 0 | | A |

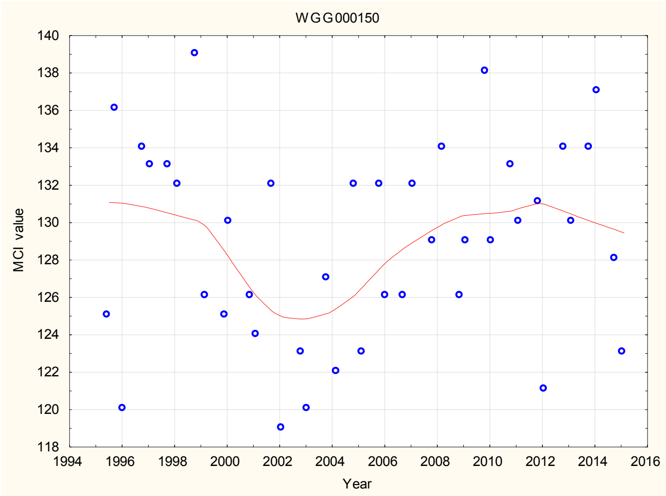
Prior to the current 2014-2015 period, 22 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', eleven 'moderately sensitive', and three 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected toward the upper mid-reaches of a 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 (*Hydropsyche-Aoteapsyche*)]. Eleven of the characteristics taxa were dominant in the spring, 2014 community. These were comprised of five 'highly sensitive', five 'moderately sensitive', and one 'tolerant' taxa. All but two of these taxa (both 'highly sensitive' taxa) were again dominant in the summer, 2015 community together with one additional 'tolerant' taxon [midge (*Polypedilum*)] not previously recorded in abundance at this site. Two taxa ('highly sensitive' mayfly, *Deleatidium* and 'moderately sensitive' mayfly, *Coloburiscus*) were recorded as extremely abundant in both spring and summer communities. The numerical dominance by similar proportions of 'highly sensitive' and 'moderately sensitive' taxa in both seasons was reflected in the relative similarity in seasonal $SQMCI_s$ values although the summer decrease of 0.4 unit was primarily due to reductions in abundances of two 'highly sensitive' taxa (Tables 156 and 157). All taxa recorded as very or extremely abundant during spring and/or summer had characterized this site's communities on 74% to 100% of past survey occasions.

### 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 (130) is seven units higher than the altitude prediction and a significant (Stark, 1998) 20 units higher than the distance predictive value while the spring, 2014 survey score (128 units) was five units above the altitude predictive value and significantly (Stark, 1998) higher than the distance predictive value. The summer, 2015 score (123 units) was also significantly higher than the distance predictive value by 13 units. Of the 40 surveys to date at this site, no MCI scores have been less than 110 units while 80% have been greater than 123 units, further indicative of the better than predicted health of the river at this site.

### 3.2.16.2.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 41
Kendall tau = + 0.068
p value = 0.534 [>FDR, p = 0.617]
N/S at p <0.05

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

An overall temporal trend of minimal change (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 (six units) has not been ecologically important over the twenty year period. Localised erosion had caused sediment deposition on the riverbed during 1999 with a subsequent five year decline in MCI scores which was of minor ecological importance (LOWESS-smoothed range of six units). This decline ceased with a gradual improvement in MCI scores towards earlier levels over the latter twelve years. The erosion event was very localised and site specific, as corresponding biological and physiochemical monitoring data showed no significant trends at the nearest downstream site (Eltham Road). Smoothed MCI scores 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 in the 'better than expected' category for almost the entire period, the exception being over the 2001 to 2005 period when health fell into the 'expected' category.

### 3.2.16.3 Eltham Road site (WGG000500)

#### 3.2.16.3.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Waingongoro River at this mid-reach site at Eltham Road between October 1995 and February 2014. 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 2014 and summer 2015 results.

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WGG000500 | 42 | 16 - 32 | 23 | 91-124 | 102 | 22 | 104 | 22 | 102 |

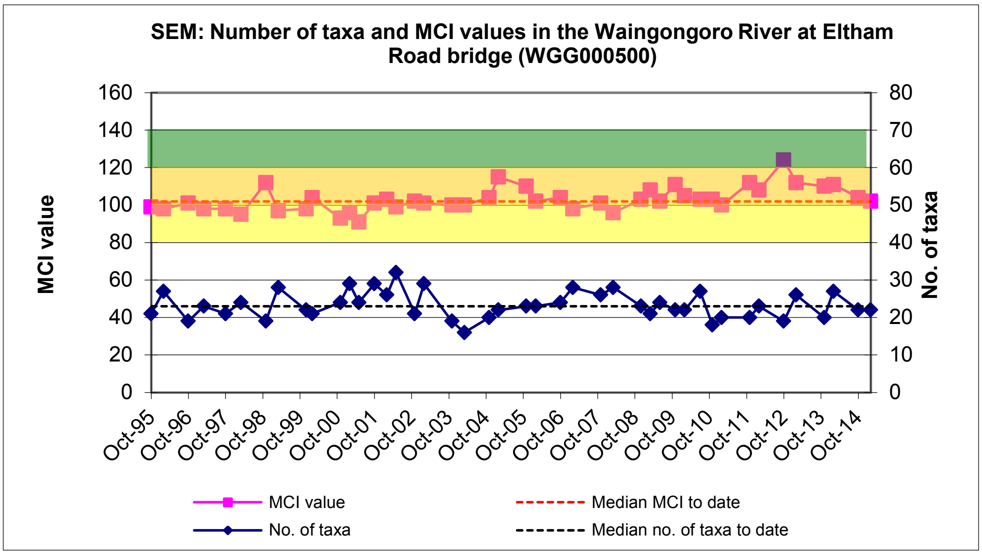



**Figure 62** Numbers of taxa a nd MCI values in the Waingongoro River at Eltham Road

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 2014-2015 period spring (22 taxa) and summer (22 taxa) richnesses were equivalent and were within one taxon of the median taxa number.

MCI values have had a relatively wide range (33 units) at this site, more typical of sites in the mid reaches of ringplain rivers. The historical median value (102 units) has been typical of mid reach sites elsewhere on the ringplain (TRC, 2015a) with the spring, 2014 (104 units) and summer, 2015 (102 units) scores typical for such a site and insignificantly up to two units higher than the historical median (coincident with minimal to moderate periphyton substrate cover in spring and summer respectively). These scores categorised this site as having 'good' (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 river. The historical median score (102 units) placed this site in the 'good' and '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 2014-2015 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 2014 [42 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 4 | 10 | | |
| **ANNELIDA** | Oligochaeta | 1 | 12 | 29 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 7 | 17 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 12 | 29 | | |
| | *Coloburiscus* | 7 | 25 | 60 | VA | A |
| | *Deleatidium* | 8 | 31 | 74 | XA | XA |
| | *Nesameletus* | 9 | 1 | 2 | | |
| **PLECOPTERA** | *Zelandobius* | 5 | 6 | 14 | A | |
| **COLEOPTERA** | Elmidae | 6 | 40 | 95 | A | VA |
| | Hydraenidae | 8 | 1 | 2 | | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 24 | 57 | A | VA |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 35 | 83 | VA | XA |
| | *Costachorema* | 7 | 16 | 38 | | |
| | *Hydrobiosis* | 5 | 26 | 62 | | A |
| | *Beraeoptera* | 8 | 1 | 2 | | |
| | *Oxyethira* | 2 | 2 | 5 | | |
| | *Pycnocentrodes* | 5 | 12 | 29 | A | |
| **DIPTERA** | *Aphrophila* | 5 | 9 | 21 | | |
| | Eriopterini | 5 | 7 | 17 | | |
| | *Maoridiamesa* | 3 | 17 | 40 | | |
| | Orthocladiinae | 2 | 23 | 55 | A | |
| | Tanytarsini | 3 | 9 | 21 | | |
| | Ceratopogonidae | 3 | 1 | 2 | | |
| | Empididae | 3 | 3 | 7 | | |
| | *Austrosimulium* | 3 | 13 | 31 | | |

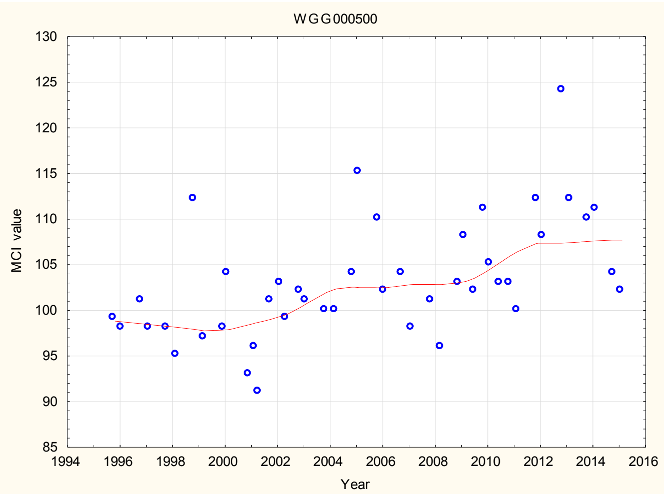
Prior to the current 2014-2015 period, 25 taxa had characterised the community at this site on occasions. These have comprised four 'highly sensitive', ten 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increase in 'tolerant' taxa as would be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Hydrobiosis*), and dobsonfly (*Archichauliodes*)]; and two 'tolerant' taxa [free-living caddisfly (*Hydropsyche-Aoteapsyche*) and orthoclad midges]. Eight of these historically characteristic taxa were dominant in the spring, 2014 community. These comprised one 'highly sensitive', five 'moderately sensitive', and two 'tolerant' taxa. Five of these taxa and one additional 'moderately sensitive' taxon, and two fewer 'moderately sensitive' and one fewer 'tolerant' taxa comprised the dominant taxa of the summer community. Five of these ten taxa were dominant in both spring and summer communities (Table 67). The increased seasonal numerical dominance within the 'tolerant' caddisfly taxon in particular resulted in a decrease (0.9 unit) in $SQMCI_s$ scores between spring and summer (Tables 156 and 157). The five taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 57% to 95% 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 (102) is three units lower than the altitude prediction and five units higher than the distance predictive value while the spring, 2014 survey score (104 units) was one unit below to seven units above predictive values and the summer, 2015 score (102 units) was three units below the predictive altitude value and an insignificant five units above the predictive distance value. Of the 44 surveys to date at this site, 11% of MCI scores have been less than 97 units while 25% have been greater than 105 units, with the majority of these higher scores in more recent years.

### 3.2.16.3.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 44
Kendall tau = +0.424
p value < 0.0001 [>FDR, p < 0.001]
Significant at p < 0.05 and p < 0.01;
and after FDR application

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

A strong positive temporal trend in MCI scores has been found over the twenty-year period which has been statistically significant at the 5% and 1% levels (after FDR application). This has been more pronounced since 2001 but scores plateaued for about three years before a more recent further improvement and another most recent plateau in scores. The range of LOWESS-smoothed range of scores (10 units) has been of marginal ecological importance over the twenty year period due to the recent plateau in scores. MCI scores consistently bordered on 'fair' to 'good' generic river health (Table 1) prior to 2003 remaining 'good' thereafter. In terms of predictive relationships (Table 2) for a site in the mid reaches of a ringplain river, health has been consistently in the 'expected' category since 2003, prior to which it bordered on the 'worse than expected' category.

### 3.2.16.4 Stuart Road site (WGG000665)

#### 3.2.16.4.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Waingongoro River at this mid-reach site at Stuart Road between October 1995 and February, 2014. 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 2014 and summer 2015 results.

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WGG000665 | 38 | 14-30 | 20 | 77-111 | 95 | 14 | 106 | 22 | 92 |

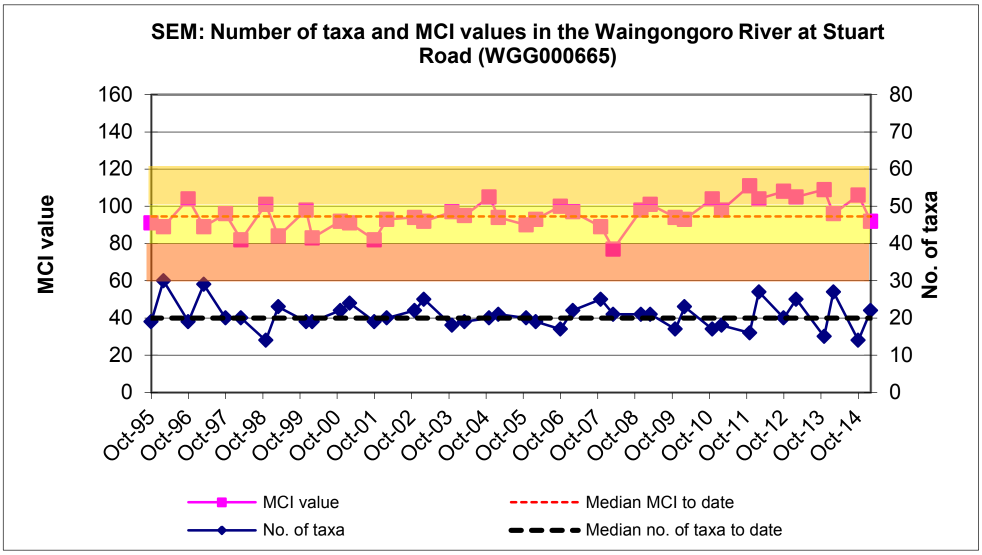



**Figure 64** Numbers of taxa and MCI values in the Waingongoro River at Stuart Road

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 2014-2015 period spring (14 taxa) and summer (22 taxa) richnesses varied from well below the median and equal with the historical minimum taxa number in spring to slightly above median taxa number in summer, coincidental with patchy substrate periphyton cover in both spring and summer.

MCI values have had a moderately wide range (34 units) at this site, typical of sites in the mid reaches of ringplain rivers. The median value (95 units) has been lower than typical of mid reach sites elsewhere on the ringplain however (TRC, 2015a), with the spring, 2014 (106 units) and summer, 2015 (92 units) scores significantly above the historical median by 11 units in spring but more typical (within three units of the 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), 'expected' (spring and summer) health for the mid reaches of a ringplain river. Improvements in biological 'health', as indicated by generally higher than median scores, have been coincidental with the July 2010 diversion of the major point source discharge (Eltham municipal wastewater) out of the catchment from the original outfall located  a relatively short distance upstream of this site. The historical median score (95 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

### 3.2.16.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 1 | 3 | | |
| **ANNELIDA** | Oligochaeta | 1 | 18 | 47 | | |
| **CRUSTACEA** | Ostracoda | 1 | 1 | 3 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 7 | 18 | | A |
| | *Coloburiscus* | 7 | 3 | 8 | A | A |
| | *Deleatidium* | 8 | 22 | 58 | XA | VA |
| **PLECOPTERA** | *Zelandobius* | 5 | 3 | 8 | | |
| **COLEOPTERA** | Elmidae | 6 | 31 | 82 | | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 2 | 5 | | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 30 | 79 | | XA |
| | *Costachorema* | 7 | 7 | 18 | | |
| | *Hydrobiosis* | 5 | 14 | 37 | | A |
| | *Beraeoptera* | 8 | 2 | 5 | | |
| | *Oxyethira* | 2 | 1 | 3 | | |
| | *Pycnocentrodes* | 5 | 8 | 21 | A | |
| **DIPTERA** | *Aphrophila* | 5 | 15 | 39 | | A |
| | *Maoridiamesa* | 3 | 26 | 68 | | VA |
| | Orthocladiinae | 2 | 35 | 92 | | VA |
| | Tanytarsini | 3 | 10 | 26 | | A |
| | Ceratopogonidae | 3 | 1 | 3 | | |
| | Empididae | 3 | 2 | 5 | | |
| | *Austrosimulium* | 3 | 11 | 29 | | |

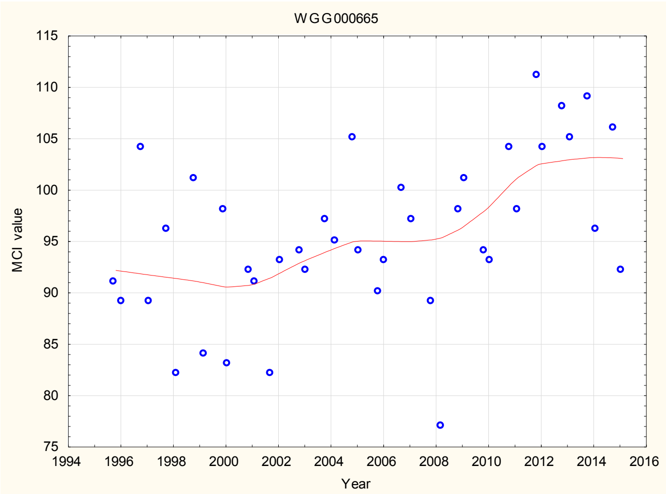
Prior to the current 2014-2015 period, 22 taxa had characterised the community at this site on occasions. These have comprised two 'highly sensitive', nine 'moderately sensitive', and eleven 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a higher proportion of 'tolerant' taxa as might be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; one 'moderately sensitive' taxon [elmid beetles]; and three 'tolerant' taxa [free-living caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. Only three of the historically characteristic taxa were dominant in the spring, 2014 community. These comprised one 'highly sensitive'  and two 'moderately sensitive' taxa. Two of these taxa plus five additional 'moderately sensitive' and four 'tolerant' taxa comprised the dominant taxa of the summer community. Only two of these 11 taxa were dominant in both spring and summer communities (Table 69). A decreased numerical dominance within one 'highly sensitive' taxon (mayfly) and increased abundances within three 'tolerant' taxa were reflected in the marked decrease (3.3 units) in summer $SQMCI_s$ score (Tables 156 and 157). The taxa (four) recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 58% to 92% 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 (95) is eight units lower than the altitude prediction and one unit above the distance predictive value. The spring, 2014 survey score (106 units) was three to a significant (Stark, 1998) 12 units higher than these predictive values and the summer, 2015 score (92 units) was a significant 11 units to two units lower than these predictive values. Of the 40 surveys to date at this site, 45% of MCI scores have been less than 94 units while only 23% have been greater than 103 units.

#### 3.2.16.4.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.365
p value < 0.001 [>FDR, p = 0.003]
Significant at p <0.05 and p < 0.01 and after FDR application

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

A very positive statistically significant trend in MCI scores has been found at the 5% and 1% levels (after FDR application) over the twenty year period. There has been a strong improvement in MCI scores since 2002 (coincident with summer diversion of the treated meatworks wastes discharge (at Eltham) from the river to land irrigation) and particularly most recently (since 2009) following the diversion of treated municipal Eltham wastewater out of the catchment (to the Hawera WWTP and ocean outfall) prior to a very recent plateau in scores. The LOWESS-smoothed range of scores (12 units) has also been ecologically important over the twenty year period. Smoothed MCI scores consistently have been indicative of 'fair' generic river health until the last four years when they have been indicative of 'good' generic health (Table 1). 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 almost throughout the period until approaching the 'better than expected' category in the last four years.

### 3.2.16.5 SH45 site (WGG000895)

#### 3.2.16.5.1 Taxa richness and MCI

Thirty-nine surveys have been undertaken in the Waingongoro River at this lower reach site at SH45 between October 1995 and February, 2014. These results are summarised in Table 70, together with the results from the current period, and illustrated in Figure 66.

**Table 70** Results of previous surveys performed in the Waingongoro River at SH45, together with spring 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WGG000895 | 39 | 16-24 | 20 | 73-106 | 95 | 20 | 102 | 25 | 94 |

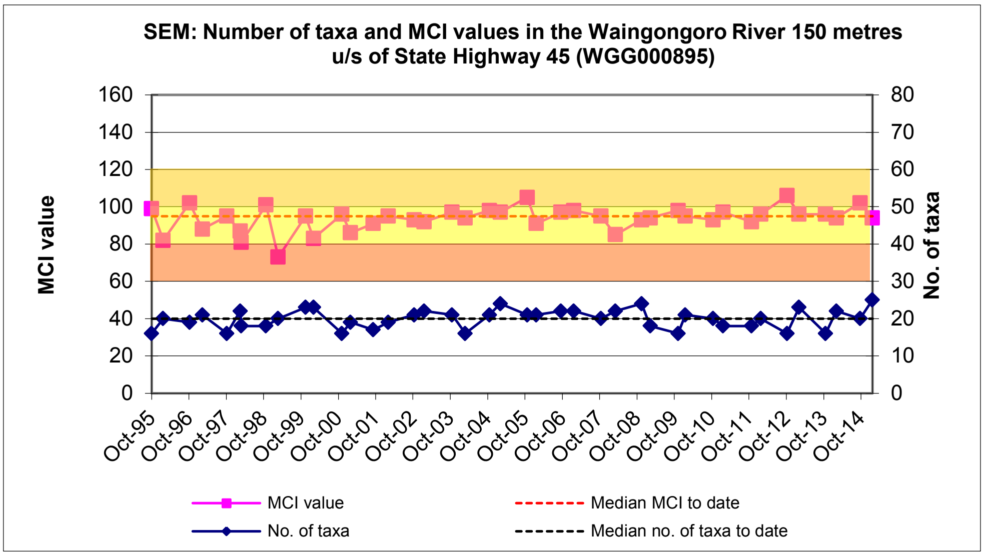



**Figure 66** Numbers of taxa and MCI values in the Waingongoro River 150 m u/s of SH45

A moderate range of richnesses (16 to 24 taxa) has been found with a median richness of 20 taxa (more representative of typical richnesses in the lower reaches of ringplain streams and rivers). During the 2014-2015 period, spring (20 taxa) and summer (25 taxa) richnesses showed a moderate summer increase coincident with more widespread substrate periphyton cover. The spring richness was equivalent with the median taxa number whereas summer richness was higher by five taxa.

MCI values have had a wide range (33 units) at this site, more typical of sites in the lower reaches of ringplain streams and rivers. The median value (95 units) has been higher than typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2015a), however. The spring, 2014 (102 units) score was seven units above the median score whereas the summer, 2015 (94 units) score was one unit below the historical median. These scores categorised this site as having 'good' health (spring) and 'fair' health (summer) generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health (spring) and 'expected' health (summer) for the lower reaches of a ringplain river. The historical median score (95 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

### 3.2.16.5.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [39 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 3 | 8 | | |
| ANNELIDA | Oligochaeta | 1 | 32 | 82 | VA | A |
| | Lumbricidae | 5 | 4 | 10 | | |
| MOLLUSCA | *Latia* | 5 | 2 | 5 | | |
| | *Potamopyrgus* | 4 | 36 | 92 | A | VA |
| EPHEMEROPTERA | *Austroclima* | 7 | 4 | 10 | | |
| | *Deleatidium* | 8 | 22 | 56 | A | |
| PLECOPTERA | *Zelandobius* | 5 | 3 | 8 | A | |
| COLEOPTERA | Elmidae | 6 | 33 | 85 | | |
| MEGALOPTERA | *Archichauliodes* | 7 | 4 | 10 | | |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 39 | 100 | | VA |
| | *Costachorema* | 7 | 2 | 5 | | |
| | *Hydrobiosis* | 5 | 18 | 46 | | |
| | *Pycnocentrodes* | 5 | 36 | 92 | VA | VA |
| DIPTERA | *Aphrophila* | 5 | 10 | 26 | | |
| | *Maoridiamesa* | 3 | 17 | 44 | A | |
| | Orthocladiinae | 2 | 20 | 51 | A | |
| | Tanytarsini | 3 | 5 | 13 | | |
| | *Austrosimulium* | 3 | 6 | 15 | | |

Prior to the current 2014-2015 period, 19 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and eight 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [elmid beetles and caddisfly (*Pycnocentrodes*)]; and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges)]. Seven of the historically characteristic taxa were dominant in the spring, 2014 community. These comprised one 'highly sensitive', two 'moderately sensitive', and four 'tolerant' taxa. Three of these taxa and one additional 'tolerant' taxon comprised the dominant taxa of the summer, 2015 community but with decreased abundances of the one 'highly sensitive', one 'moderately sensitive', and two 'tolerant' taxa (Table 71). These differences in seasonal dominances, but particularly a decrease in abundance of very 'tolerant' oligochaete worms, were reflected in the small increase of 0.6 unit in seasonal $SQMCI_s$ scores (Tables 156 and 157).

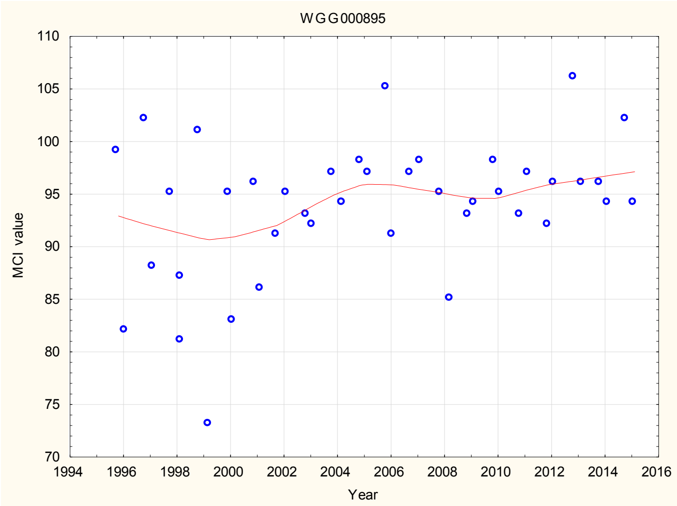
The four taxa recorded as very abundant during spring and/or summer have characterised this site's communities on 82% to 100% of past survey occasions.

#### 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 six units higher than the altitude prediction and ten units higher than the predictive distance value. The spring, 2014 survey score (102 units) was a significant (Stark, 1998) 13 units higher than the altitude predictive value and also significantly 17 units higher than the predictive distance value while the summer, 2015 score (94 units) was five units higher than the predictive altitude value and nine units above the predicted distance value. Of the 41 surveys to date at this site, 10% of MCI scores have been less than 85 units while 80% have been greater than 89 units.

#### 3.2.16.5.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 41
Kendall tau = +0.193
p value = 0.075 [>FDR, p = 0.122]
N/S at p < 0.05

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

A positive trend in MCI scores has been found over the twenty year period, particularly since 2000 followed by a general plateauing in trend since 2005, but the overall trend has not been statistically significant. The narrow LOWESS-smoothed range (six units) of scores has not been ecologically important. 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 'expected' category throughout the period, although health has more recently bordered on the 'better than expected' category.

### 3.2.16.6 Ohawe Beach site (WGG000995)

#### 3.2.16.6.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Waingongoro River at this lower reach site at Ohawe Beach between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WGG000995 | 38 | 12-25 | 18 | 69-100 | 91 | 22 | 98 | 20 | 91 |

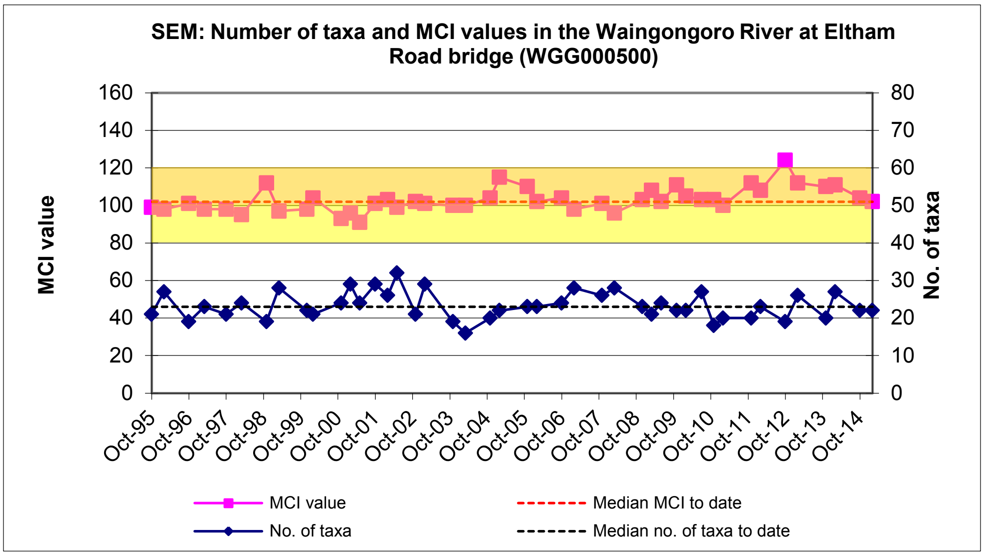



**Figure 68** Numbers of taxa and MCI values in the Waingongoro River at the Ohawe Beach site

A wide range of richnesses (12 to 25 taxa) has been found, with a median richness of 18 taxa. During the 2014-2015 period, spring (22 taxa) and summer (20 taxa) richnesses were similar and four taxa more than the median richness in spring and two taxa higher in summer when filamentous algal substrate cover was more extensive.

MCI values have had a relatively wide range (31 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been more typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (98 units) and summer, 2015 (91 units) scores were dissimilar and up to seven units above the historical median, and showed a typical summer seasonal decrease. These scores categorised this site as having 'fair' health generically (Table 1) in spring and summer 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 (91 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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **ANNELIDA** | Oligochaeta | 1 | 27 | 71 | A | |
| | Lumbricidae | 5 | 1 | 3 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 30 | 79 | A | VA |
| **CRUSTACEA** | *Paratya* | 3 | 2 | 5 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 2 | 5 | | |
| | *Deleatidium* | 8 | 8 | 21 | A | |
| **PLECOPTERA** | *Zelandobius* | 5 | 0 | 0 | A | |
| **COLEOPTERA** | Elmidae | 6 | 22 | 58 | | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 37 | 97 | A | XA |
| | *Costachorema* | 7 | 1 | 3 | | |
| | *Hydrobiosis* | 5 | 3 | 8 | | |
| | *Pycnocentrodes* | 5 | 31 | 82 | XA | VA |
| **DIPTERA** | *Aphrophila* | 5 | 8 | 21 | | |
| | *Maoridiamesa* | 3 | 29 | 76 | A | |
| | Orthocladiinae | 2 | 36 | 95 | A | VA |
| | Tanytarsini | 3 | 7 | 18 | | |
| | Ephydridae | 4 | 2 | 5 | | |
| | *Austrosimulium* | 3 | 4 | 11 | | |

Prior to the current 2014-2015 period, 17 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', seven 'moderately sensitive', and nine 'tolerant' taxa i.e. a lower proportion of 'sensitive' taxa and a higher proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included two 'moderately sensitive' taxa [elmid beetles and stony-cased caddisfly (*Pycnocentrodes*)]; and five 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)], but no 'highly sensitive' taxa. Seven of the historically characteristic taxa were dominant in the spring, 2014 community together with one 'moderately sensitive' taxon [stonefly (*Zelandobius*)] not previously found in abundance at this site. These comprised one 'highly sensitive', one 'moderately sensitive', and five 'tolerant' taxa, whereas four of these same taxa but two fewer 'tolerant' taxa and two fewer 'sensitive' taxa comprised the dominant taxa of the summer, 2015 community. Although four of these eight taxa were dominant in both spring and summer communities (Table 73), some overall increase in numerical abundances within three 'tolerant' taxa and decreased abundances within two 'sensitive' taxa combined to reduce the summer $SQMCI_s$ score by 0.9 unit (Tables 156 and 157).

The four taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 79% to 95% of past survey occasions.

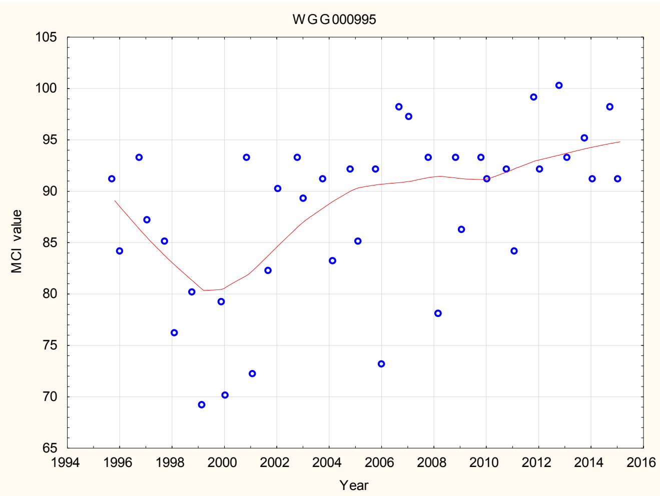
### 3.2.16.6.3 Predicted stream 'health'

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 (91) is six units higher than both the predictive values. The spring, 2014 survey score (98 units) was a significant 13 units higher than both predictive values while the summer score (91 units) was six units higher than the predictive altitude and distance values. Of the 40 surveys to date at this site, 30% of MCI scores have been less than 85 units while 65% have been greater than 85 units.

#### 3.2.16.6.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.350
p value = 0.001 [>FDR, p = 0.004]
Significant at p <0.05 and p < 0.01; and after FDR.

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

There has been a marked trend of MCI scores improvement since 2001, which tended to plateau between 2006 and 2009, with a recent more gradual improvement resulting in an overall twenty-year temporal trend which has been statistically significant ($p < 0.01$ after FDR application). The range of LOWESS-smoothed scores (15 units) has been ecologically important, mainly due to the influence of a series of low scores (<81 MCI units) between 1998 and 2001 and the elevation in scores subsequent to diversion of major mid-catchment point source discharges out of the river, particularly since 2009.

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 approached 'poor'. In terms of predictive relationships (Table 2) for a site in the lower reaches of a ringplain stream, river health has remained in the 'expected' category until most recently when it has improved to border on the 'better than expected' category.

### 3.2.16.7 Discussion

Seasonal MCI values typically decreased between spring and summer at five of the six sites by five, two, 14, eight, and seven units in a downstream direction with the exception of the upper site where there was an atypical large increase of 14 units. The decreases tended to be slightly higher than historical seasonal median differences (by 0 to nine units) at the corresponding sites (Appendix II). Seasonal communities shared 57% of the 37 taxa, a lower percentage than usual, found at the upper site near the National Park; 54% of 35 taxa at the Opunake Road upper mid-reach site; 69% of 26 taxa at the Eltham Road mid-reach site; 50% of 24 taxa at the Stuart Road mid-reach site; 50% of 25 taxa at the SH45 lower reach site; and 50% of 28 taxa at the furthest downstream site (Ohawe Beach) in the lower reaches. Seasonal community compositions in the 2014-2015 period therefore tended to follow typical trends of generally greater dissimilarity with increasing distance downstream from the National Park, although the range of dissimilarities was not as wide as usual.

Community composition varied markedly through the length of the river surveyed. A total of 46 taxa was recorded in spring of which only seven taxa were present at all six sites. These included one 'highly sensitive' taxon, five 'moderately sensitive' taxa, and one 'tolerant' taxon with only the 'highly sensitive' mayfly (*Deleatidium*) abundant at all six sites. A slightly higher total of 48 taxa was found along the river's length by the summer survey of which seven taxa were present at all six sites. These were relatively similar to the widespread taxa found in spring with two 'tolerant', four 'moderately sensitive' and one 'highly sensitive' taxa. However, no taxa were abundant at all six sites in summer. Dissimilarities in spatial community structure along the length of the Waingongoro River were only very slightly more pronounced in summer than in spring.

The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 27 units in spring and 48 units in summer, over a river distance of 65.9 km. These seasonal falls in MCI scores equated to average rates of decline of 0.4 unit/km (spring) and 0.7 unit/km (summer), compared with a predicted average 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 most past trends, when there have been increased summers' seasonal average rates of decline. These relatively low average rates of decline (for a ringplain river or stream) may be explained principally 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 site and mid-reach site at Eltham Road, the spring (0.9 unit/km) and summer (1.7 units/km) average rates of decline were lower (spring) and higher (summer) than the predicted average rate (1.5 units/km) for the equivalent river reach. For the mid-reach Eltham Road site to Ohawe Beach lower reach site, spring (0.1 unit/km) and summer (0.25 unit/km) average rates of decline were slightly lower than the predicted average rate of 0.3 unit/km. Previously, higher average rates of decline had been recorded between the Eltham Road and Stuart Road mid-reach sites (6.6 km reach) in spring and particularly in summer compared with the predicted average 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 summer removal of the meatworks discharge and the complete diversion of the municipal wastes (post July 2010) these average rates have reduced. The average rates in spring 2014 (no change) and in summer 2015 (2.3 units/km) have continued to reflect these seasonal differences.

Using the long-term median SEM MCI scores for each site (Appendix II), the average rates of decline between upper and mid catchment (Eltham Road) sites and mid catchment (Eltham Road) and lower river sites have been about 1.3 and 0.25 units per km respectively with an overall average rate of decline of 0.6 MCI unit/km over the river's length. Therefore average rates of decline over the 2014-2015 period were lower (spring) and higher (summer) for the upper to mid reach and lower in spring and equal in summer for the mid to lower reach of the river than have been typical of average rates prior to 2014.

## 3.2.17 Mangawhero Stream

The results found by the 2014-2015 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-eight surveys have been undertaken in this mid-reach site in the Mangawhero Stream within about 3 km of the Ngaere swamp between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MWH000380 | 38 | 10-24 | 15 | 58-85 | 75 | 13 | 74 | 18 | 77 |

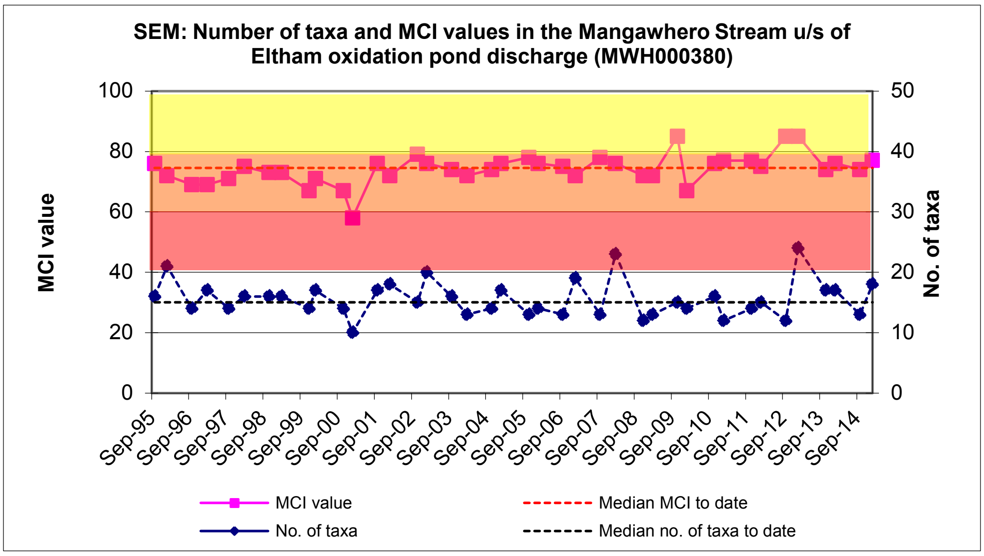



**Figure 70** Numbers of taxa and MCI values in the Mangawhero Stream upstream of Eltham WWTP

A moderately wide range of richnesses (10 to 24 taxa) has been found, with a median richness of 15 taxa (more representative of typical richnesses in small swamp drainage streams where a median richness of 18 taxa has been recorded from 179 previous surveys of 'control' sites at similar altitudes (TRC, 2015a)). During the 2014-2015 period, spring (13 taxa) and summer (18 taxa) richnesseses were dissimilar but within three taxa of the historical median. (However, it is noted that rarities (fewer than 5 individuals per taxon) comprised 38% of the spring community compared with 50% of the summer community). The habitat was predominantly comprised of a hard clay substrate with widespread filamentous algae substrate cover in spring but patchy algal mats cover only in summer.

MCI values have had a moderate range (27 units) at this site. The median value (75 units) has been typical of similar non-ringplain sites elsewhere in the region however, and the very similar spring, 2014 (74 units) and summer, 2015 (77 units) scores were also very similar to the historical median for this site. These scores categorised this site as having 'poor' (spring and summer) health generically (Table 1) and were two to five units lower than the median MCI score (79 units) recorded by 179 previous surveys of similar 'control' sites in small, non ringplain streams in Taranaki (TRC, 2015a).The historical median score (75 units) placed this site in the 'poor' category for the generic method of assessment and was four 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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 1 | 3 | | |
| ANNELIDA | Oligochaeta | 1 | 25 | 66 | A | |
| | Lumbricidae | 5 | 1 | 3 | | |
| MOLLUSCA | *Potamopyrgus* | 4 | 2 | 5 | | |
| CRUSTACEA | Ostracoda | 1 | 9 | 24 | | |
| | *Paracalliope* | 5 | 31 | 82 | A | VA |
| EPHEMEROPTERA | *Austroclima* | 7 | 35 | 92 | | |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 17 | 45 | | |
| | *Hydrobiosis* | 5 | 6 | 16 | | |
| | *Polyplectropus* | 6 | 1 | 3 | | |
| | *Oxyethira* | 2 | 4 | 11 | | |
| DIPTERA | *Aphrophila* | 5 | 19 | 50 | | |
| | *Chironomus* | 1 | 2 | 5 | | |
| | *Maoridiamesa* | 3 | 8 | 21 | | |
| | Orthocladiinae | 2 | 36 | 95 | A | |
| | *Austrosimulium* | 3 | 17 | 45 | | VA |

Prior to the current 2014-2015 period, 16 taxa had characterised the community at this site on occasions. These have comprised six 'moderately sensitive' and ten 'tolerant' taxa i.e. an absence of 'highly sensitive' taxa and a relatively high proportion of 'tolerant' taxa as would be expected in the drain-like reaches of a non-ringplain, swampy, seepage stream.

Predominant taxa have included three 'moderately sensitive' taxa [amphipod (*Paracalliope*), mayfly (*Austroclima*), and cranefly (*Aphrophila*)]; and two 'tolerant' taxa [oligochaete worms and orthoclad midges].

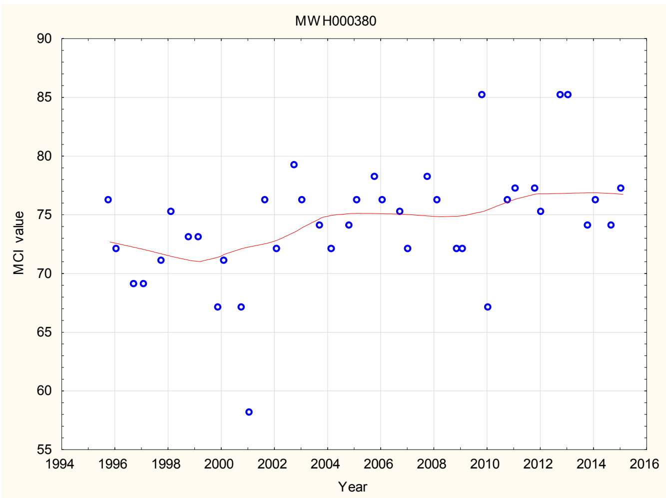
Three of the historically characteristic taxa were dominant in the spring, 2014 community and were all predominant taxa (above). The summer, 2015 community was characterised by only one of the taxa dominant in spring plus one 'tolerant' taxon which previously had been predominantly characteristic of this site's communities (Table 75). An increase in abundance within one 'sensitive' summer taxon and decrease in abundances of two 'very tolerant' taxa resulted in an insignificant increase in $SQMCI_s$ scores (0.6 unit) between seasons (Tables 158 and 159). The two taxa which were recorded as very abundant during spring and/or summer had characterised this site's communities on 45% to 82% 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. This site is at an altitude of 200 m asl and toward its upper reaches. Relationships for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), therefore are not applicable to this site in this type of stream.

### 3.2.17.1.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.344
p value = 0.002 [>FDR, p = 0.004]
Significant at p <0.05 and p < 0.01 levels; and after FDR application

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

A positive, statistically significant temporal trend in MCI scores ($p < 0.01$ after FDR) has been found over the twenty year monitoring period at this site with the early trend of slightly increasing scores having been followed by a plateauing of scores a few units above those recorded early in the programme, then another small increase and plateau in recent years. However, the narrow range of LOWESS-smoothed scores (six units) has not been of ecological importance over the twenty year period. LOWESS-smoothed MCI scores consistently have been indicative of 'poor' generic stream health (Table 1) throughout the period. However, due to the often weedy, more drain-like nature of this site, the more recently established SBMCI 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-eight surveys have been undertaken at this lower mid-reach site in the Mangawhero Stream between October 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| MWH000490 | 38 | 13-30 | 19 | 63-102 | 79 | 20 | 97 | 27 | 88 |

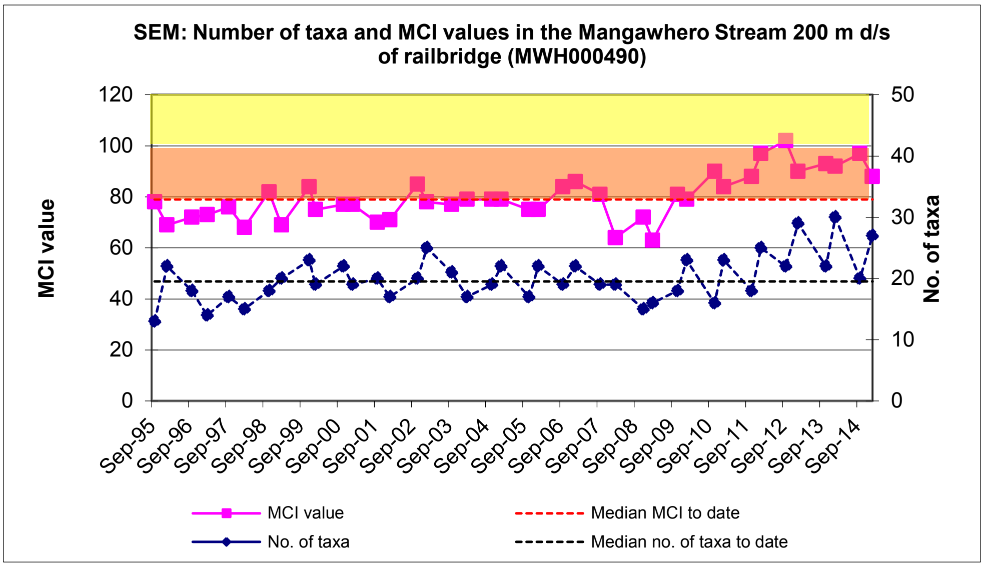



**Figure 72** Numbers of taxa and MCI values in the Mangawhero Stream downstream of the railbridge and Mangawharawhara Stream confluence

A relatively wide range of richnesses (13 to 30 taxa) has been found with a moderate median richness of 19 taxa (more representative of typical richnesses in the lower-mid reaches of streams and rivers). During the 2014-2015 period, spring (20 taxa) and summer (27 taxa) richnesses were quite different and from one to eight taxa more than this median richness.

MCI values have had a wide range (39 units) at this site, more typical of a site in the middle to lower reaches of ringplain streams. However, the median value (79 units) has been lower than typical of lower mid-reach sites elsewhere. The spring, 2014 (97 units) and summer, 2014 (88 units) scores were 9 units to a significant (Stark, 1998) 18 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. 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' (spring) to 'worse than expected' (summer) health for the equivalent reaches of a stream with some ringplain catchment component (Mangawharawhara Stream which rises outside of the National Park). The historical median score (79 units) placed this site in the 'poor' and 'worse than expected' categories for generic and predictive methods of assessment respectively. The historical median score continues to reflect both the more lowland, swampy, 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 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| ANNELIDA | Oligochaeta | 1 | 38 | 100 | A | VA |
| MOLLUSCA | *Physa* | 3 | 2 | 5 | | |
| | *Potamopyrgus* | 4 | 12 | 32 | | A |
| CRUSTACEA | Cladocera | 5 | 3 | 8 | | |
| | Ostracoda | 1 | 26 | 68 | | |
| | *Paracalliope* | 5 | 34 | 89 | | VA |
| | Paraleptamphopidae | 5 | 2 | 5 | | |
| | Talitridae | 5 | 2 | 5 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 3 | 8 | | |
| | *Deleatidium* | 8 | 9 | 24 | A | VA |
| PLECOPTERA | *Zelandobius* | 5 | 2 | 5 | | |
| COLEOPTERA | Elmidae | 6 | 8 | 21 | | VA |
| MEGALOPTERA | *Archichauliodes* | 7 | 1 | 3 | | |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 66 | | XA |
| | *Costachorema* | 7 | 1 | 3 | | |
| | *Hydrobiosis* | 5 | 12 | 32 | | VA |
| | *Oxyethira* | 2 | 9 | 24 | | |
| | *Pycnocentria* | 7 | 2 | 5 | | |
| | *Pycnocentrodes* | 5 | 7 | 18 | | A |
| DIPTERA | *Aphrophila* | 5 | 8 | 21 | | |
| | *Chironomus* | 1 | 2 | 5 | | |
| | *Maoridiamesa* | 3 | 20 | 53 | VA | |
| | Orthocladiinae | 2 | 35 | 92 | VA | VA |
| | *Polypedilum* | 3 | 1 | 3 | | |
| | Tanypodinae | 5 | 1 | 3 | | |
| | Tanytarsini | 3 | 2 | 5 | | A |
| | Empididae | 3 | 0 | 0 | | A |
| | Muscidae | 3 | 2 | 5 | | |
| | *Austrosimulium* | 3 | 13 | 34 | | |

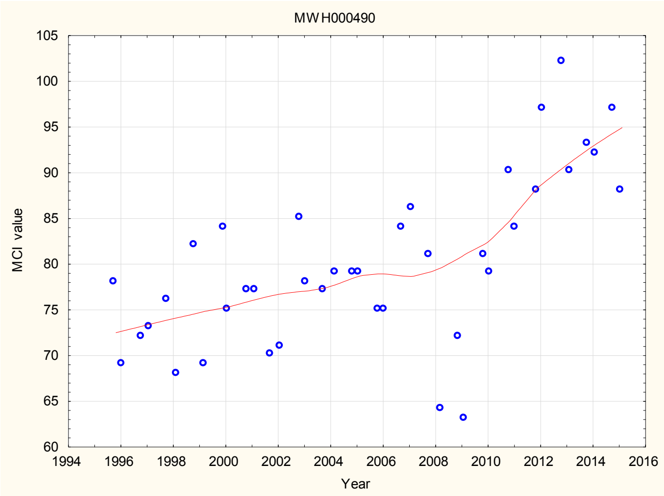
Prior to the current 2014-2015 period, 28 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', fourteen 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa than might be expected at this altitude (190 m asl) in the downstream reaches of a small stream with a ringplain component. Predominant taxa have included one 'moderately sensitive' taxon [amphipod (*Paracalliope*)] and five 'tolerant' taxa [oligochaete worms, ostracod seed shrimps, net-building caddisfly (*Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)]. Three of these predominant taxa were dominant in the spring, 2014 community together with only one of the other historically characteristic taxa (of which the 'highly sensitive' mayfly had been characteristic of the community on less than 25% of previous occasions). The summer, 2015 community was characterised by three of the same taxa dominant in spring, together with eight additional taxa; one of which (a 'tolerant' taxon) previously had not been characteristic of this site's communities (Table 77). The repeated abundance of the 'highly sensitive' mayfly (*Deleatidium*) and several characteristic 'moderately sensitive' taxa were further confirmation of improved water quality (and habitat) conditions following Eltham WWTP wastewater diversion. Seasonal dissimilarities in several of the characteristic taxa, and increased summer abundances within some 'sensitive' taxa were reflected in the summer increase of 1.0 unit in $SQMCI_s$ scores (Tables 158 and 159). All taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 21% to 100% of the past surveys with three of the 'sensitive' taxa on less than 34% of occasions, more coincident with 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 (79 units) was very significantly lower than this altitude prediction while the spring, 2014 (97 units) and summer, 2015 (88 units) scores were also below this predictive value by an insignificant seven units and a significant 16 units respectively but it must be noted that only part of the catchment is of ringplain derivation. Of the 40 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 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty years 1995-2015) of SEM results collected to date from the site in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for this site. The LOWESS (tension 0.4) trend plot of MCI data is presented in Figure 73.




N = 40
Kendall tau = +0.489
p value < 0.0001 [>FDR, p < 0.001]
Significant at p <0.05 and p < 0.01; and significant after FDR

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

A moderate, then recently much more pronounced, and now statistically significant (p < 0.01, 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 wide range in LOWESS-smoothed scores (22 units) has more recently become ecologically important over this twenty year period. Scores plateaued for 3 years after a steady improvement between 1995 and 2006 prior to the more recent marked improvement due to improved scores since the diversion of the Eltham WWTP wastes discharge out of the stream in July 2010.

The MCI scores generally have been indicative of 'poor' generic stream health (Table 1) with sporadic incursions into the 'fair' health category prior to 2010. The LOWESS-smoothed scores remained in the 'poor' category through the period until 2010 and subsequently improved into the 'fair' category and more recently toward 'good' health. 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' almost throughout the entire twenty year period, but entered the 'expected' category in the 2011-2012 survey period where it has remained.

### 3.2.17.3 Discussion

Seasonal MCI values atypically increased by three units between spring and summer at the upper reach (upstream of the Eltham WWTP), in comparison with the historical median summer decrease (two units, Appendix II) for this site. A more typical but larger decrease (nine units) was found at the lower site (downstream of the Mangawharawhara Stream confluence) in the absence of the WWTP discharge which had significantly impacted on water quality at this site prior to mid 2010. This was larger in comparison with a seasonal three unit median summer historical decrease at this site (Appendix II). Seasonal communities at the upper reach site shared only nine common taxa (41% of the 22 taxa found in 2014-2015, despite the relatively similar MCI scores) compared with 19 shared common taxa (68% of the 28 taxa) at the lower site; a less typical seasonal change in community structure than historically found at the upper of the two sites. The two sites shared nine common taxa (38% of the 24 taxa) in spring and 13 common taxa (41% of 32 taxa) in summer, indicative of the dissimilarity in spatial community structures in both spring and 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 23 units in spring and 11 units in summer, over a stream distance of 16.5 km between the upper and lower sites of this stream. This was principally as a result of the variability and improvement in physical habitat and physicochemical water quality conditions in a downstream direction between the two sites which have been enhanced in recent years by the diversion of the Eltham wastewater discharge out of the stream.

The very low flow conditions at the time of the summer survey may also have contributed to the seasonal difference in rate of downstream MCI improvement.

## 3.2.18 Huatoki Stream

The results of spring (2014) and summer (2014-2015) 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

Thirty-six surveys have been undertaken, between December 1996 and February 2014, 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 2014 and summer 2015 results

| Site code | SEM data ( 1996 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | January 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| HTK000350 | 36 | 22-34 | 26 | 79-114 | 96 | 25 | 103 | 31 | 104 |

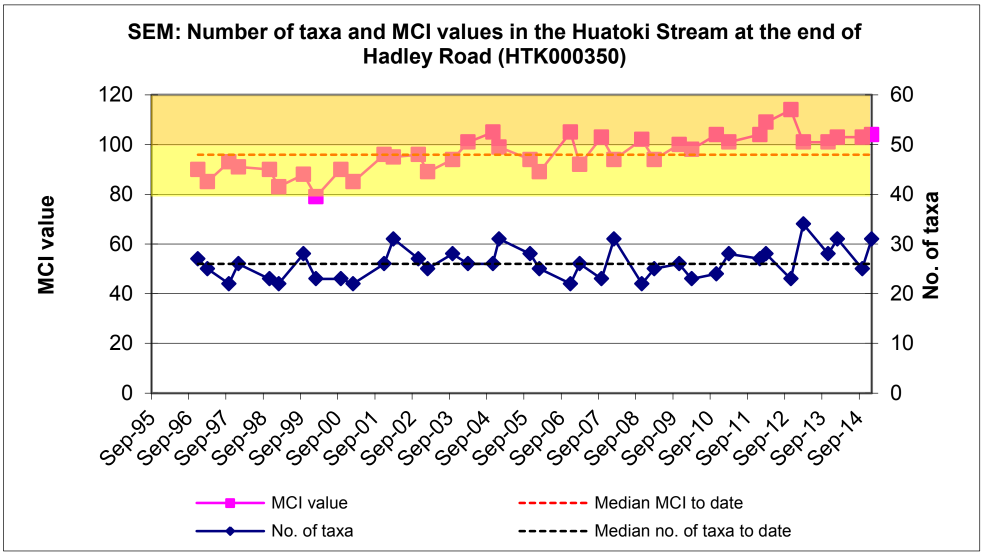



**Figure 74** Numbers of taxa and MCI values in the Huatoki Stream at the end of Hadley Drive

A moderate range of richnesses (22 to 34 taxa) has been found with a relatively high median richness of 26 taxa, relatively typical of richnesses in the mid to lower reaches of ringplain streams rising outside of the National Park. During the 2014-2015 period spring (25 taxa) and summer (31 taxa) richnesses were relatively different and from one taxon less to five taxa more than the historical median richness coincident with thinner periphyton mats and more patchy filamentous algae cover in summer on the predominantly stony-bouldery substrate of this unshaded site. The summer richness was within three taxa of the maximum recorded to date for this site, although 29% of taxa were present as rarities (less than 5 individuals per taxon) in this summer community.

MCI values have had a relatively wide range (35 units) at this site, typical of mid to lower reach sites on the ringplain. The historical median value (96 units) also has been typical of mid-reach sites rising outside the National Park elsewhere on the ringplain (TRC, 2015a), and the spring, 2014 (103 units) and summer, 2015 (104 units) scores were an insignificant (Stark, 1998) seven to eight 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 the altitude predictive relationship (Table 2), 'better than expected' (spring and summer) health for the mid-reaches of a ringplain stream on these occasions. The historical median score (96 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 2014-2015 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 February 2014 [36 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 3 | 8 | | |
| **ANNELIDA** | Oligochaeta | 1 | 23 | 64 | A | A |
| **MOLLUSCA** | *Latia* | 5 | 4 | 11 | | |
| | *Potamopyrgus* | 4 | 22 | 61 | | |
| **CRUSTACEA** | *Paracalliope* | 5 | 6 | 17 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 11 | 31 | A | A |
| | *Coloburiscus* | 7 | 21 | 58 | VA | VA |
| | *Deleatidium* | 8 | 7 | 19 | VA | VA |
| | *Nesameletus* | 9 | 13 | 36 | | A |
| | *Zephlebia group* | 7 | 23 | 64 | A | VA |
| **PLECOPTERA** | *Zelandobius* | 5 | 10 | 28 | VA | |
| | *Zelandoperla* | 8 | 1 | 3 | | |
| **COLEOPTERA** | Elmidae | 6 | 14 | 39 | VA | VA |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 6 | 17 | A | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 35 | 97 | VA | VA |
| | *Costachorema* | 7 | 19 | 53 | A | A |
| | *Hydrobiosis* | 5 | 23 | 64 | | A |
| | *Neurochorema* | 6 | 3 | 8 | | |
| | *Oxyethira* | 2 | 4 | 11 | | |
| | *Pycnocentrodes* | 5 | 4 | 11 | | |
| **DIPTERA** | *Aphrophila* | 5 | 18 | 50 | | |
| | *Maoridiamesa* | 3 | 19 | 53 | | |
| | Orthocladiinae | 2 | 33 | 92 | | VA |
| | Tanytarsini | 3 | 14 | 39 | | A |
| | Empididae | 3 | 1 | 3 | | |
| | Muscidae | 3 | 5 | 14 | | |
| | *Austrosimulium* | 3 | 16 | 44 | A | |

Prior to the current 2014-2015 period 27 taxa had characterised the community at this site on occasions. These have comprised only three 'highly sensitive' taxa, but 13 'moderately sensitive' and 11 'tolerant' taxa i.e. a relatively high proportion of 'tolerant' taxa as would be expected in the lower mid-reaches of a ringplain stream rising outside the National Park.

Predominant taxa have included no 'highly sensitive' taxa; five 'moderately sensitive' taxa [mayflies (*Coloburiscus* and *Zephlebia* group), free-living caddisflies (*Hydrobiosis* and *Costachorema*), and cranefly (*Aphrophila*)]; and five 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)].

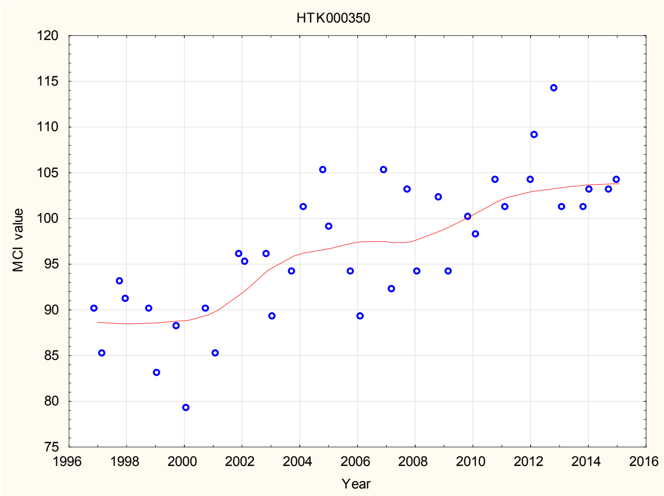
Eleven of the historically characteristic taxa were dominant in the spring, 2014 community comprising five of the predominant taxa (above) together with six of the other historically characteristic taxa. The summer, 2015 community was characterised by nine of the taxa dominant in spring, together with an additional one 'highly sensitive', one 'moderately sensitive', and two 'tolerant' taxa, all of which previously had been characteristic of this site's communities, but with one fewer 'moderately sensitive' taxon and one fewer 'tolerant' taxon characteristic of the spring community. Despite a few differences in numerical abundances within one 'sensitive' and one 'tolerant' taxa there was no change in the seasonal $SQMCI_s$ scores (Table 160 and 161). The seven taxa which were recorded as very abundant during spring and/or summer had characterised this site's communities on 19% to 97% 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 (96 units) is only five units above this altitude prediction while the spring survey score (103 units) and the summer score (104 units) were significantly (Stark, 1998) higher by 12 units (spring) and 13 units (summer) than the predictive value. Of the 38 surveys to date at this site, 29% of MCI scores have been less than 91 units. The current spring and summer MCI scores were higher than the majority of historical scores.

#### 3.2.18.1.4 Temporal trends in 1996 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the nineteen 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 = 38
Kendall tau = +0.559
p level < 0.0001 [>FDR, p < 0.001]
Significant at p< 0.05 and p < 0.01; 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 wide LOWESS-smoothed range of MCI scores (15 units) has ecological importance and may have been related to improvements in farming practices (including more recent riparian fencing) and/or wastes disposal in the rural catchment between the stream's seepage sources (below the National Park) and urban New Plymouth.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) almost throughout the period improving to 'good' health since 2010. 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 nineteen year period and more 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

Thirty-six surveys have been undertaken at this lower reach site in the Huatoki Stream toward the downstream boundary of the Huatoki Domain between December 1996 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1996 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Jan 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| HTK000425 | 36 | 17-32 | 26 | 91-115 | 103 | 26 | 105 | 27 | 105 |

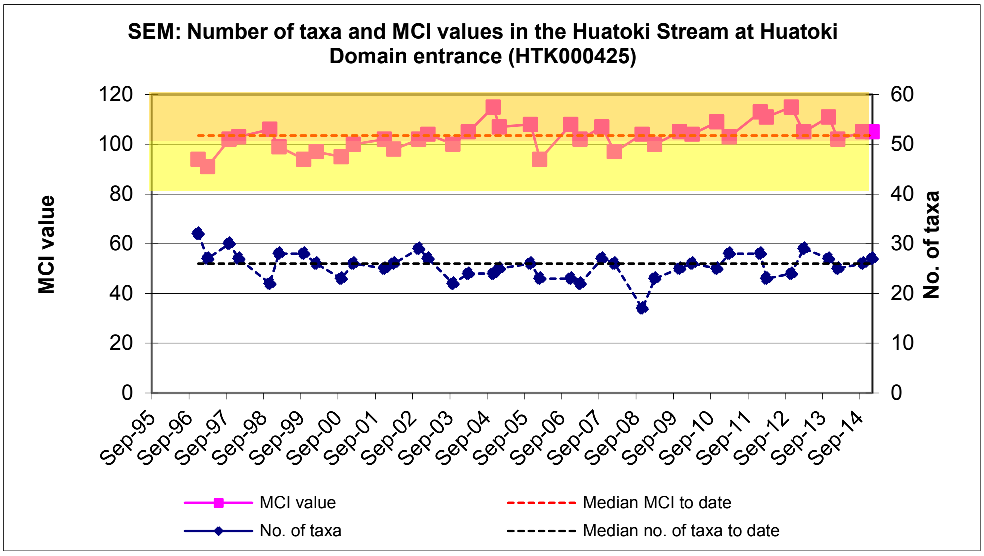



**Figure 76** Numbers of taxa and MCI values in the Huatoki Stream at the Huatoki Domain

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 2014-2015 period spring (26 taxa) and summer (27 taxa) richnesses increased very slightly in summer with seasonal richnesses both within one taxon of this median richness.

MCI values have had a moderately wide range (24 units) at this site. The median value (103 units) has been higher than typical of lower reach sites elsewhere on the ringplain however. The spring, 2014 (105 units) and summer, 2015 (105 units) scores were also higher than typical for such a site and two units above the historical median. These scores categorised this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of the altitude predictive relationship (Table 2), 'better than expected' (spring and 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 (103 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 2014-2015 period are listed in Table 81.

**Table 81** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Huatoki Stream at Huatoki Domain, between 1996 and February 2014 [36 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 3 | 8 | | |
| **ANNELIDA** | Oligochaeta | 1 | 31 | 86 | A | |
| **MOLLUSCA** | *Latia* | 5 | 15 | 42 | | |
| | *Potamopyrgus* | 4 | 31 | 86 | A | A |
| **CRUSTACEA** | *Paracalliope* | 5 | 3 | 8 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 10 | 28 | A | VA |
| | *Coloburiscus* | 7 | 31 | 86 | VA | VA |
| | *Deleatidium* | 8 | 8 | 22 | VA | A |
| | *Mauiulus* | 5 | 1 | 3 | | |
| | *Nesameletus* | 9 | 1 | 3 | | |
| | *Zephlebia group* | 7 | 33 | 92 | | |
| **PLECOPTERA** | *Zelandobius* | 5 | 17 | 47 | A | |
| **COLEOPTERA** | Elmidae | 6 | 25 | 69 | VA | VA |
| | Ptilodactylidae | 8 | 3 | 8 | | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 17 | 47 | A | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 35 | 97 | A | A |
| | *Costachorema* | 7 | 1 | 3 | | |
| | *Hydrobiosis* | 5 | 7 | 19 | | A |
| | *Pycnocentrodes* | 5 | 20 | 56 | A | |
| **DIPTERA** | *Aphrophila* | 5 | 1 | 3 | | |
| | Orthocladiinae | 2 | 10 | 28 | A | |
| | *Austrosimulium* | 3 | 34 | 94 | A | |
| | Tanyderidae | 4 | 1 | 3 | | |

Prior to the current 2014-2015 period, 23 taxa had characterised the community at this site on occasions. These have comprised three '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; four 'moderately sensitive' taxa [mayflies (*Zephlebia* group and *Coloburiscus*), elmid beetles, and stony-cased caddisfly (*Pycnocentrodes*)]; and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and sandfly (*Austrosimulium*)].

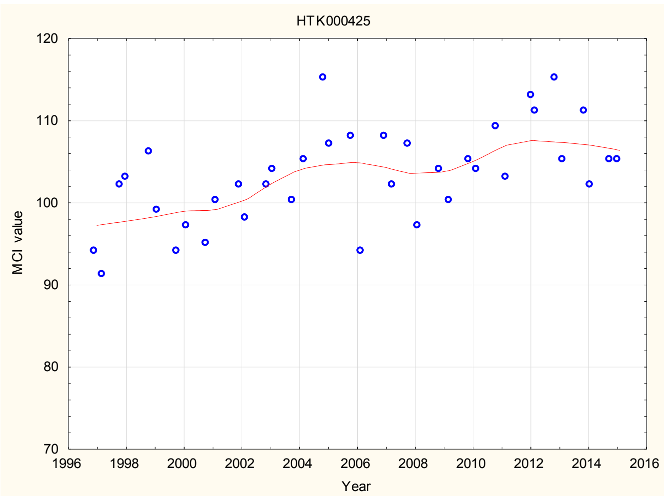
Twelve of the historically characteristic taxa were dominant in the spring, 2014 community and these were comprised of seven of the predominant taxa (above) together with an additional one 'highly sensitive', three 'moderately sensitive', and one 'tolerant' taxa. The summer, 2015 community was characterised by six of the taxa dominant in spring, with a single additional 'moderately sensitive' taxon and three fewer 'moderately sensitive' and three fewer 'tolerant' taxa than characteristic of the spring community (Table 81). Four significant differences in numerical abundances within all taxa between seasons resulted in minimal change in seasonal $SQMCI_s$ scores (0.1 unit)(Tables 160 and 161). The four taxa which were recorded as very abundant during spring and/or summer had characterised this site's communities on 22% to 86% of past surveys.

#### 3.2.18.2.3 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site at Hadley Domain is in the lower mid-reaches at an altitude of 30 m asl. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 87 units for this site. The historical site median (103 units) is well above this altitude prediction coincident with the extensive riparian vegetation cover of the Huatoki Domain and both the spring survey score (105 units) and the summer score (105 units) were significantly higher (Stark, 1998) by 18 units than the predictive value. Of the 38 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 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the nineteen 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 = 38
Kendall tau = +0.420
p level = 0.0002 [>FDR, p < 0.001]
Significant at p< 0.05 and p < 0.01; 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 as strong as that found at the upstream site (at Hadley Drive), was identified at this site in the Domain although scores peaked with small decreases after 2006 and 2012. The overall trend has been very statistically significant after FDR application (p< 0.01) and the LOWESS-smoothed range of scores (10 units) although onlyof marginal ecological importance. The trend has probably been related to the upstream catchment activities noted above (Section 3.2.18.1.4) as no nearby habitat changes have been recorded within the Domain.

The smoothed MCI scores which indicated 'fair' generic stream health (Table 1) much earlier in the monitoring period, improved to 'good' stream health where they have remained 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 entire period, 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

Thirty-six surveys have been undertaken at this lower reach site in the Huatoki Stream between December 1996 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1996 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Jan 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| HTK000745 | 36 | 14-27 | 22 | 69-101 | 86 | 21 | 92 | 19 | 62 |

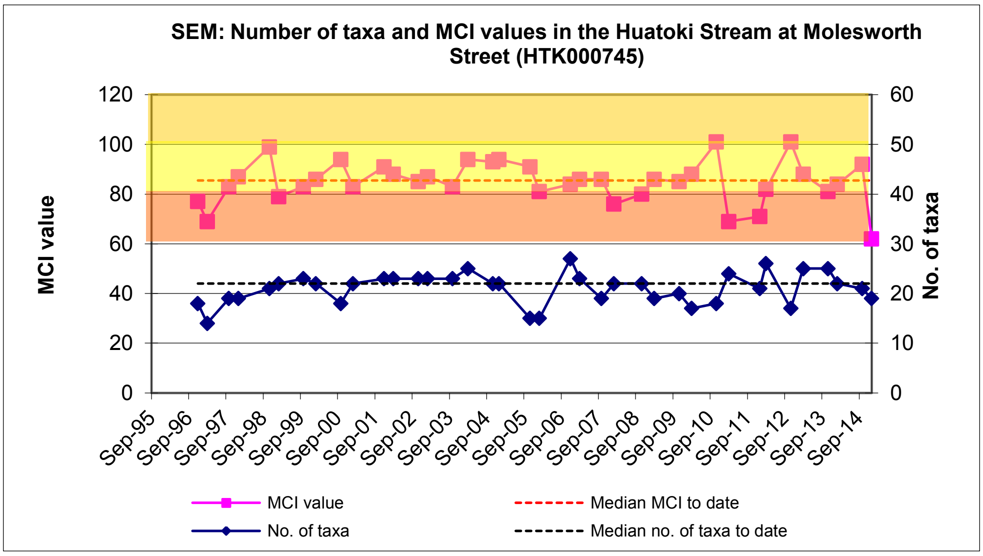



**Figure 78** Numbers of taxa and MCI values in the Huatoki Stream at Molesworth Street (near coast)

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 2014-2015 period spring (21 taxa) and summer (19 taxa) richnesses were relatively similar and slightly lower than (spring and summer) this median richness.

MCI values have had a relatively wide range (32 units) at this site. The median value (86 units) has been typical of lower reach sites elsewhere on the ringplain, however. The spring, 2014 (92 units) and summer, 2015 (62 units) scores were significantly (Stark, 1998) different. The spring score was insignificantly six units higher than the historical median whereas the summer score was a significant 24 units below this median and seven units below the previous minimum. These scores were coincidental with pulsed flows a short distance downstream of a relatively recently installed weir and fish pass (for beautification purposes) and a reduction in the cobble component of the substrate in summer. They categorised this site as having 'fair (spring) and 'poor' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), '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 2014-2015 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 2015 [36 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 1 | 3 | | |
| **ANNELIDA** | Oligochaeta | 1 | 36 | 100 | XA | XA |
| **MOLLUSCA** | *Ferrissia* | 3 | 1 | 3 | | |
| | *Latia* | 5 | 3 | 8 | | |
| | *Potamopyrgus* | 4 | 36 | 100 | VA | XA |
| | Sphaeriidae | 3 | 0 | 0 | | A |
| **CRUSTACEA** | Ostracoda | 1 | 1 | 3 | | |
| | *Paratya* | 3 | 3 | 8 | | |
| **EPHEMEROPTERA** | *Coloburiscus* | 7 | 4 | 11 | | |
| | *Zephlebia group* | 7 | 5 | 14 | A | |
| **PLECOPTERA** | *Zelandobius* | 5 | 3 | 8 | | |
| **COLEOPTERA** | Elmidae | 6 | 20 | 56 | XA | XA |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 3 | 8 | | |
| | *Oxyethira* | 2 | 1 | 3 | | |
| | *Pycnocentrodes* | 5 | 10 | 28 | | |
| | *Triplectides* | 5 | 2 | 6 | | |
| **DIPTERA** | *Aphrophila* | 5 | 1 | 3 | | |
| | Orthocladiinae | 2 | 14 | 39 | | |
| | *Polypedilum* | 3 | 1 | 3 | | |
| | Empididae | 3 | 2 | 6 | | |
| | *Austrosimulium* | 3 | 1 | 3 | | |
| | Tanyderidae | 4 | 5 | 14 | | |

Prior to the current 2014-2015 period, 21 taxa had characterised the community at this site on occasions. These have comprised no 'highly sensitive', eight 'moderately sensitive', and 13 '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 only one 'moderately sensitive' taxon [elmid beetles] and two 'tolerant' taxa [oligochaete worms and snail (*Potamopyrgus*); both "tolerant" taxa on every occasion].

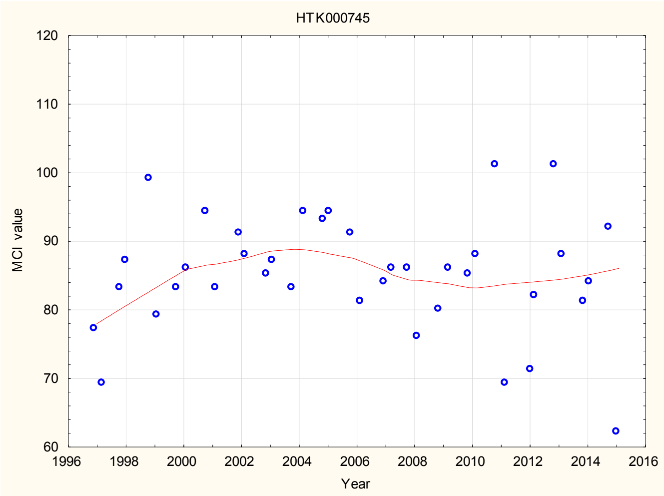
Four of the historically characteristic taxa were dominant in the spring, 2014 community and comprised all of the predominant 'tolerant' taxa (above) and one additional 'moderately sensitive' mayfly taxon. The summer, 2015 community was characterised by the same three predominant taxa from spring, loss of the moderately sensitive' mayfly taxon, and addition of one 'tolerant' taxon (sphaerid clam) not previously recorded in abundance at this site. Despite the loss of one 'moderately sensitive' taxon, the similarity in numerically most predominant taxa between seasons was reflected in the identical spring and summer $SQMCI_s$ scores (Tables 160 and 161). The three taxa which were recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 56% to 100% of past surveys.

#### 3.2.18.3.3 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site near the coast is in the lower reaches at an altitude of 5 m asl. A relationship for ringplain streams developed between MCI and site altitude (Stark and Fowles, 2009), predicts a MCI value of 85 units for this site. The historical site median (86 units) is only one unit above this altitude prediction while the spring score (92 units) was an insignificant seven units above this predictive score whereas the summer score (62 units) was a significant 23 units below the predictive value. Of the 38 surveys to date at this site, 45% of MCI scores have been less than 85 units, indicating that the current summer MCI score was far less typical of historical conditions.

#### 3.2.18.3.4 Temporal trends in 1996 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the nineteen 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 = 38
Kendall tau = + 0.017
p level = 0.878 [>FDR, p = 0.895]
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 smoothed MCI scores had occurred at this urbanised site until 2005 after which scores trended downward until plateauing more recently (with much more variability amongst individual scores) following the pulsed flows and subtle habitat changes caused by the beautification project which involved construction of a weir and a fishpass This has resulted in an overall very weak positive and statistically non-significant trend for the nineteen year monitoring period. However, the range of LOWESS-smoothed scores (11 units) has some ecological importance probably related in part to those activities noted for the two sites further upstream in the Huatoki catchment (see above) and the stream enhancement project specific to the reach immediately upstream of this site.

Smoothed MCI scores indicative of 'fair' generic stream health (Table 1) have been recorded for all but the first years 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 throughout the nineteen year monitoring period.

### 3.2.18.4 Discussion

Seasonal MCI values typically decreased between spring and summer at only the one site by a significant 30 units at the coastal site, whereas there was an insignificant summer increase of one unit (Hadley Drive site) and no change at the Huatoki Domain site. These results may be compared with historical median seasonal data (Appendix II) which indicate typical small summer MCI decreases of six units at the Hadley Drive site, three units at the Huatoki Domain site, and minimal change near the coast. Seasonal communities shared 60% of the 35 taxa found at the mid-reach Hadley Drive site, 61% of 33 taxa at Huatoki Domain, but only 33% of 30 taxa at the furthest downstream site in the lower reaches near the coast. This was indicative of the least dissimilarity in seasonal community composition at the more stable Huatoki Domain site and by far the greatest dissimilarity at the furthest downstream site.

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 significant variation in community composition. This site's seasonal faunal communities were characterised by increases in the 'tolerant' taxa proportion of each of the community compositions.

Community composition varied markedly through the mid reach to lower reach length of the stream surveyed. A total of 37 taxa was recorded in spring of which only thirteen taxa (35%) were present at all three sites. These included one 'highly sensitive', seven 'moderately sensitive', and five 'tolerant' taxa with only one 'moderately sensitive' taxon (elmid beetles) and one 'tolerant' taxon (oligochaete worms) abundant at all three sites. An inceased total of 42 taxa was found along the stream's surveyed length by the summer survey when only nine taxa (21%) were present at all three sites. Six of these taxa were the same as the widespread taxa in spring with the addition of one 'highly sensitive' and four 'tolerant' taxa and addition of one 'tolerant taxon which was not as widespread in spring. One 'moderately sensitive' taxon ['moderately sensitive' elmid beetles] was abundant at all three sites in summer,. Dissimilarities in spatial community structure along the surveyed length (mid to lower reaches) of the Huatoki Stream were more pronounced in summer  as has often been found in the past.

MCI score increased atypically (for ringplain streams) in a downstream direction by two units in spring and by one unit 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, in comparison with increases recorded by most past surveys (e.g. historical median scores have increased by five units (spring) and eight units (summer) between these sites (Appendix II)). MCI score fell by 13 units (spring) and much more significantly by 43 units (summer) through the city between the Domain and the coast, despite a change in elevation of only 25 m, representing a  relatively high average rate of MCI decrease of 3.2 and 10.6 units/km respectively. Both spring and summer decreases were well above the average rate expected through the mid to lower reaches of Taranaki ringplain rivers and streams sourced outside of the National Park (TRC, 2015a). These MCI rates of decrease were amplified by the presence of the improved habitat within the Huatoki Domain and (particularly in summer) by the more recent deterioration in habitat adjacent to the coastal site. There were decreases in MCI between the open farmland site and the coast of 11 units (spring) and 42 units (summer) coincident with some impacts of urbanisation on the stream's macroinvertebrate fauna.

Using the long-term median SEM MCI scores for each site (Appendix II), the average rate of decline between mid-reach site (Hadley Drive) and lower reach site (near the coast) has been 1.5 MCI units/km over the surveyed length. Therefore average rates of MCI decline over the 2014-2015 period were slightly higher in spring and much higher in summer than the historical median average rate for the 1995 to 2014 period.

## 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, 2014 survey are presented in Table 162 and the summer, 2014-2015 survey in Table 163, Appendix I.

### 3.2.19.1 Opunake Road site (KPK000250)

#### 3.2.19.1.1 Taxa richness and MCI

Thirty-one surveys have been undertaken in the Kaupokonui River at this upper mid-reach site at Opunake Road (draining relatively open farmland approximately 3.3 km downstream of the National Park) between March 1998 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1998 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KPK000250 | 31 | 20-36 | 27 | 124-138 | 129 | 30 | 139 | 22 | 139 |

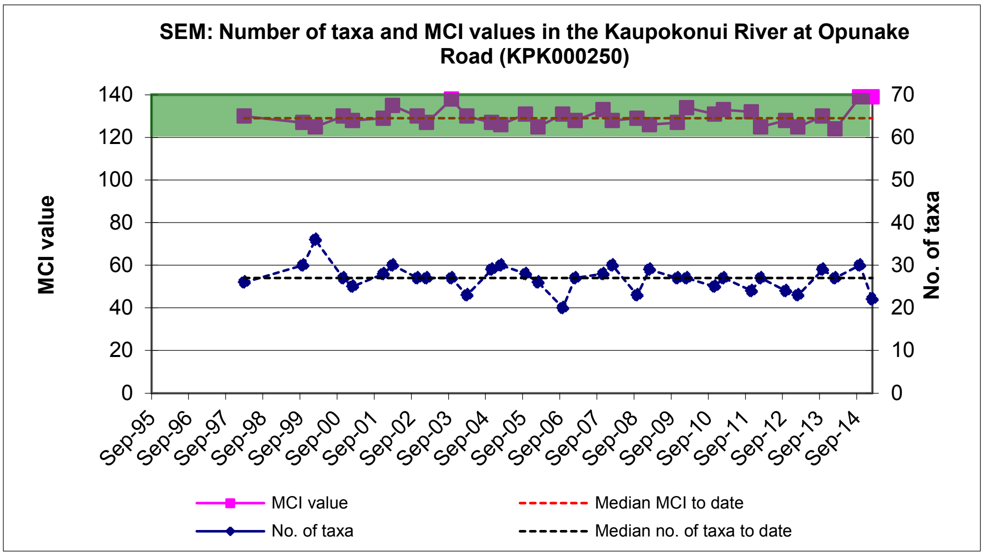



**Figure 80** Numbers of taxa and MCI values in the Kaupokonui River at Opunake Road

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 2014-2015 period spring (30 taxa) and summer (22 taxa) richnesses were dissimilar and from three taxa higher to five taxa lower than of the median richness despite minimal substrate periphyton cover on both occasions at this site.

MCI values have had a narrow range (14 units) at this site, more typical of sites in the upper reaches of ringplain rivers. The median value (129 units) has been higher than typical of mid-reach sites elsewhere on the ringplain however, with identical spring, 2014 (139 units) and summer, 2015 (139 units) scores well above those typical for such a site. These were 10 units above the historical median with both scores one unit above the historical maximum MCI value. These scores categorised this site as having 'very good', bordering on 'excellent', (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health on both occasions for the upper mid reaches of a ringplain river. The historical median score (129 units) placed this site in the 'very good' and '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 2014-2015 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 2014 [31 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| ANNELIDA | Oligochaeta | 1 | 2 | 6 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 3 | 10 | | |
| | *Coloburiscus* | 7 | 29 | 94 | XA | VA |
| | *Deleatidium* | 8 | 31 | 100 | VA | VA |
| | *Nesameletus* | 9 | 14 | 45 | | A |
| PLECOPTERA | *Acroperla* | 5 | 1 | 3 | | |
| | *Megaleptoperla* | 9 | 20 | 65 | | A |
| | *Zelandoperla* | 8 | 29 | 94 | VA | |
| COLEOPTERA | Elmidae | 6 | 31 | 100 | VA | |
| | Hydraenidae | 8 | 3 | 10 | | |
| MEGALOPTERA | *Archichauliodes* | 7 | 7 | 23 | | |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 81 | VA | A |
| | *Costachorema* | 7 | 5 | 16 | | |
| | *Hydrobiosis* | 5 | 4 | 13 | | |
| | *Beraeoptera* | 8 | 23 | 74 | VA | |
| | *Helicopsyche* | 10 | 3 | 10 | A | |
| | *Olinga* | 9 | 19 | 61 | VA | VA |
| | *Pycnocentrodes* | 5 | 11 | 35 | A | |
| DIPTERA | *Aphrophila* | 5 | 29 | 94 | A | A |
| | Eriopterini | 5 | 6 | 19 | | |
| | *Maoridiamesa* | 3 | 7 | 23 | | |
| | Orthocladiinae | 2 | 8 | 26 | | |

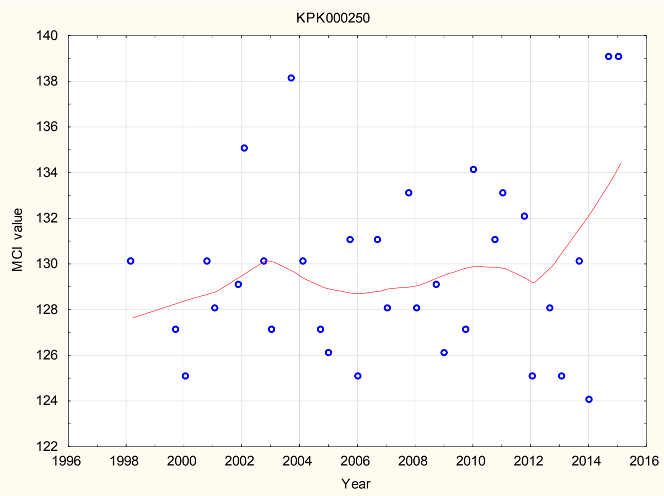
Prior to the current 2014-2015 period, 22 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', ten 'moderately sensitive', and four 'tolerant' taxa i.e. a majority of 'sensitive' taxa as would be expected in the upper mid-reaches of a ringplain stream. Predominant taxa have included five 'highly sensitive' taxa [mayfly (*Deleatidium*, on every sampling occasion), stoneflies (*Megaleptoperla* and *Zelandoperla*), and cased caddisflies (*Beraeoptera* and *Olinga*)]; three 'moderately sensitive' taxa [mayfly (*Coloburiscus)*, elmid beetles, and cranefly (*Aphrophila*)]; and one 'tolerant' taxon [net-building caddisfly (*Hydropsyche-Aoteapsyche*)]. Eight of these predominant taxa were dominant in the spring, 2014 community together with two other 'sensitive' taxa previously characteristic of this site. Altogether, these were comprised of five 'highly sensitive', four 'moderately sensitive', and one 'tolerant' taxa. Five of these predominant taxa were again dominant in the summer, 2015 community together with another two 'highly sensitive' taxa. Despite the decrease in number and abundances within dominant taxa in the summer community, there was a small rise in the summer $SQMCI_s$ value of 0.6 unit mainly due to higher numerical proportional abundances of two 'highly sensitive' taxa (Tables 162 and 163). All taxa recorded as very or extremely abundant during spring and/or summer had characterized this site's communities on 61% 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 six units higher than the altitude prediction and a significant (Stark, 1998) 11 units higher than the distance predictive value. The spring, 2013 survey score (139 units) was a significant 16 to 21 units higher than these predictive values, as was the summer, 2015 score (139 units). Of the 31 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 2015 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 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 = 33
Kendall tau = +0.065
p level = 0.597 [>FDR,p = 0.660]
N/S at p< 0.05

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

The temporal trend of a very slight improvement in MCI scores has not been statistically significant at this site in the upper mid-reaches of the river over the sixteen year monitoring period (Note: This trend previously had been slightly negative prior to the two relatively high scores recorded in the current period). The LOWESS-smoothed range of scores (six units) has been narrow and not ecologically important. 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 upper mid reaches of a ringplain river, health has been in the 'expected' category 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

Thirty-four surveys have been undertaken in the Kaupokonui River at this mid-reach site at the site upstream of the Kaponga oxidation ponds system between February 1996 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1996 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KPK000500 | 34 | 20-33 | 26 | 98-133 | 117 | 22 | 124 | 26 | 110 |

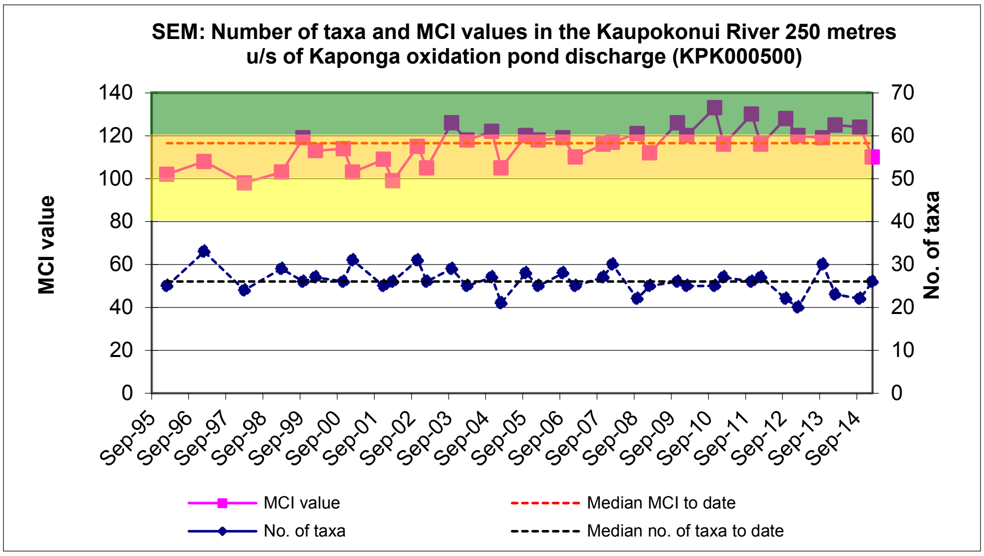



**Figure 82** Numbers of taxa and MCI values in the Kaupokonui River upstream of Kaponga oxidation pond system

A moderate range of richnesses (20 to 33 taxa) has been found with a median richness of 26 taxa, typical of richnesses in the mid reaches of ringplain streams and rivers. During the 2014-2015 period, spring (22 taxa) and summer (26 taxa) richnesses were dissimilar but within 4 taxa of the median taxa number coincidental with increased patchy filamentous algae substrate cover in summer.

MCI values have had a relatively wide range (35 units) at this site, slightly wider than typical of sites in the mid-reaches of ringplain rivers. The median value (117 units) has been very slightly higher than typical of mid-reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (124 units) and summer, 2015 (110 units) scores were significantly different and seven units higher (spring) and seven units lower (summer) than the historical median. These scores categorised this site as having 'very good' (spring) and 'good' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' health in spring and 'expected' health in summer for the mid-reaches of a ringplain river. The historical median score (117 units) placed this site in the 'good' and '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 2014-2015 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 2014 [34 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 2 | 6 | | |
| **ANNELIDA** | Oligochaeta | 1 | 6 | 18 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 3 | 9 | A | VA |
| | *Coloburiscus* | 7 | 33 | 97 | XA | VA |
| | *Deleatidium* | 8 | 29 | 85 | VA | VA |
| | *Nesameletus* | 9 | 17 | 50 | A | |
| **PLECOPTERA** | *Megaleptoperla* | 9 | 1 | 3 | | |
| | *Zelandoperla* | 8 | 8 | 24 | A | |
| **COLEOPTERA** | Elmidae | 6 | 31 | 91 | A | A |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 17 | 50 | A | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 30 | 88 | VA | XA |
| | *Costachorema* | 7 | 19 | 56 | | |
| | *Hydrobiosis* | 5 | 9 | 26 | | VA |
| | *Beraeoptera* | 8 | 17 | 50 | A | A |
| | *Olinga* | 9 | 5 | 15 | | |
| | *Oxyethira* | 2 | 1 | 3 | | |
| | *Pycnocentrodes* | 5 | 19 | 56 | VA | |
| **DIPTERA** | *Aphrophila* | 5 | 33 | 97 | VA | A |
| | Eriopterini | 5 | 5 | 15 | | |
| | *Maoridiamesa* | 3 | 23 | 68 | | VA |
| | Orthocladiinae | 2 | 22 | 65 | | A |
| | Tanytarsini | 3 | 5 | 15 | | A |
| | Empididae | 3 | 1 | 3 | | |
| | Muscidae | 3 | 3 | 9 | | A |
| | *Austrosimulium* | 3 | 1 | 3 | | |

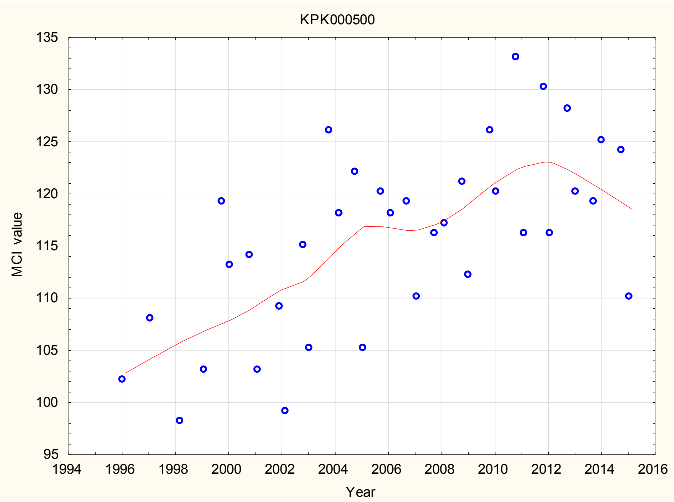
Prior to the current 2014-2015 period, 25 taxa had characterised the community at this site on occasions. These have comprised six 'highly sensitive', nine 'moderately sensitive', and ten 'tolerant' taxa i.e. a majority of 'sensitive' taxa but a small downstream increase in 'tolerant' taxa compared with the Opunake Road site, as would be expected in the mid-reaches of a ringplain river. Predominant taxa have included three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*) and flare-cased caddisfly (*Beraeoptera*)]; six 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Costachorema*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [free-living caddisfly (*Hydropsyche-Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)]. Eleven of the historically characteristic taxa were dominant in the spring, 2014 community. These comprised four 'highly sensitive' taxa, six 'moderately sensitive' taxa, and one 'tolerant' taxon. Eight of these taxa were also dominant in the summer community (Table 87) when one additional 'moderately sensitive' and four addidional 'tolerant' taxa, but two fewer 'highly sensitive' and one fewer 'moderately sensitive' taxa were dominant. Decreased numerical dominances in several 'sensitive' taxa and increased numerical dominances in several 'tolerant' taxa resulted in a decrease of 1.4 units in $SQMCI_s$ scores between spring and 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 9% to 97% 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 (117) is 6 units higher than the altitude prediction and 10 units higher than the distance predictive values. The spring, 2014 survey score (124 units) was significantly 13 units to 17 units above predictive values and the summer, 2015 score (110 units) was one unit below the predictive altitude value and three units above the predictive distance value. Of the 36 surveys to date at this site, 19% of MCI scores have been less than 107 units while 69% have been greater than 111 units.

#### 3.2.19.2.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the nineteen 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 = 36
Kendall tau = +0.437
p level <0.001 [>FDR, p < 0.001]
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 nineteen-year period which has been statistically significant at the 1% level after FDR application. This was more pronounced prior to 2006 when scores plateaued for about three years before another recent gradual improvement and most recent fall in trend. The wide range of LOWESS-smoothed scores (20 units) has ecological improvance over the 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) prior to 'very good' health over the last six years. 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 first thirteen years of the period trending more recently into the 'better than expected' category.

### 3.2.19.3 Site upstream of Kapuni railbridge (KPK000660)

#### 3.2.19.3.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Kaupokonui River at this mid-reach site upstream of the Kapuni railbridge between December 1995 and February 2013. 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 2014 and summer 2015 results

| Site code | SEM data ( 1996 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KPK000660 | 38 | 15-32 | 24 | 71-128 | 103 | 22 | 109 | 27 | 100 |

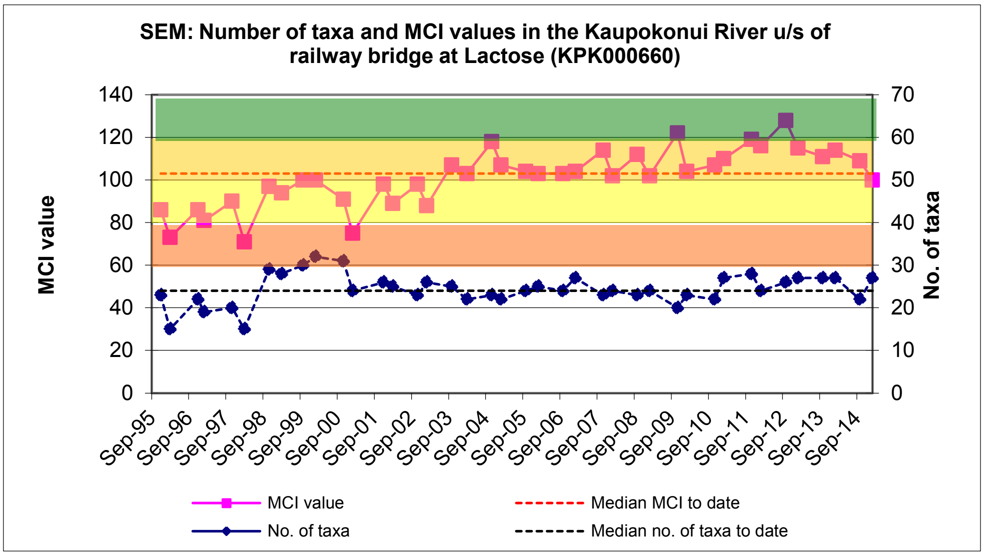



**Figure 84** Numbers of taxa and MCI values in the Kaupokonui River upstream of Kapuni railbridge

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 2014-2015 period spring (22 taxa) and summer (27 taxa) richnesses were dissimilar and from two taxa fewer to three taxa higher than the median taxa number coincident with typical patchy mats and filamentous algal cover in both spring and summer.

MCI values have had a very wide range (57 units) at this site, much wider than typical of sites elsewhere in the mid reaches of ringplain rivers. However, the median value (103 units) has been relatively typical of mid reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (109 units) and summer, 2015 (100 units) scores were more typical of this site on each occasion, with these scores six units higher (spring) and three units lower (summer) than the historical median. These scores categorised this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' in spring and summer for the mid reaches of a ringplain river. The historical median score (103 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 2014-2015 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 2014 [36 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 9 | 24 | | |
| **ANNELIDA** | Oligochaeta | 1 | 18 | 47 | A | |
| | Lumbricidae | 5 | 1 | 3 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 8 | 21 | | A |
| **CRUSTACEA** | Ostracoda | 1 | 1 | 3 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 3 | 8 | | A |
| | *Coloburiscus* | 7 | 20 | 53 | VA | A |
| | *Deleatidium* | 8 | 27 | 71 | VA | VA |
| | *Nesameletus* | 9 | 2 | 5 | | |
| **PLECOPTERA** | *Acroperla* | 5 | 1 | 3 | | |
| **HEMIPTERA** | *Sigara* | 3 | 1 | 3 | | |
| **COLEOPTERA** | Elmidae | 6 | 31 | 82 | VA | VA |
| | Hydraenidae | 8 | 2 | 5 | | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 18 | 47 | A | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 21 | 55 | VA | XA |
| | *Costachorema* | 7 | 5 | 13 | A | A |
| | *Hydrobiosis* | 5 | 15 | 39 | | A |
| | *Beraeoptera* | 8 | 5 | 13 | | |
| | *Olinga* | 9 | 2 | 5 | | |
| | *Oxyethira* | 2 | 6 | 16 | | |
| | *Pycnocentrodes* | 5 | 9 | 24 | | |
| **DIPTERA** | *Aphrophila* | 5 | 22 | 58 | VA | |
| | Eriopterini | 5 | 1 | 3 | | |
| | *Chironomus* | 1 | 1 | 3 | | |
| | *Maoridiamesa* | 3 | 22 | 58 | VA | |
| | Orthocladiinae | 2 | 29 | 76 | VA | VA |
| | Tanytarsini | 3 | 4 | 11 | | A |
| | Empididae | 3 | 2 | 5 | | |
| | Muscidae | 3 | 2 | 5 | | |
| | *Austrosimulium* | 3 | 5 | 13 | | |

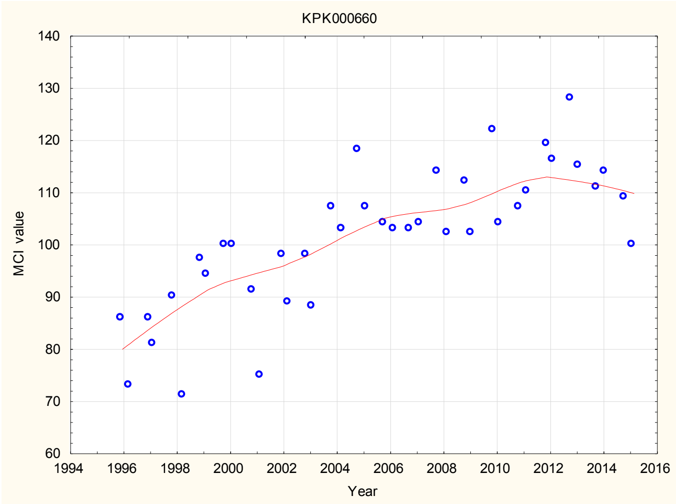
Prior to the current 2014-2015period, 30 taxa had characterised the community at this site on occasions. These have comprised five 'highly sensitive', eleven 'moderately sensitive', and fourteen 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a higher proportion of 'tolerant' taxa as might be expected in the mid reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; three 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. Ten of the historically characteristic taxa (seven of which have been predominant) were dominant in the spring, 2014 community. These comprised one 'highly sensitive', five 'moderately sensitive', and four 'tolerant' taxa. Seven of these taxa plus two 'moderately sensitive' and two 'tolerant' taxa comprised the dominant taxa of the summer community but there were one fewer 'moderately sensitive' and two fewer 'tolerant' taxa dominant. Therefore, seven of these fourteen taxa were dominant in both spring and summer communities (Table 89). The decreased numerical dominance in two 'sensitive' taxa and increased dominance within one 'tolerant' taxon in particular in summer was reflected in the small drop of 0.4 unit in summer $SQMCI_s$ score (Tables 162 and 163). The seven taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 53% to 82% 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 (103) is one unit above the altitude prediction and two units above the distance predictive value. However, the spring, 2014 survey score (109 units) was higher than both predictive values by seven to eight units while the summer, 2015 score (100 units) was slightly lower than both predictive values by one to two units. Of the 40 surveys to date at this site, 43% of MCI scores have been less than 101 units while 53% have been greater than 102 units.

#### 3.2.19.3.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.598
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 over a twenty year period at this mid-catchment site and only recently appears to have plateaued. This trend has been similar to, but stronger than, that found at the nearest site upstream and the particularly wide range of LOWESS-smoothed scores (33 units) has been ecologically very important. Fonterra factory wastewater irrigation activities nearby in this catchment have been better managed during this period and surveillance monitoring has reported improved dairy shed waste treatment ponds systems compliance upstream of this site.

The trend in generic river health (Table 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 the 'worse than expected' category (prior to 1999), through 'expected' (from 1997 to 2010), to the 'better than expected' category where it has remained since 2010.

### 3.2.19.4 Upper Glenn Road site (KPK000880)

#### 3.2.19.4.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Kaupokonui River at this lower reach site at Upper Glenn Road between 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1996 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KPK000880 | 38 | 14-31 | 19 | 66-110 | 91 | 21 | 95 | 18 | 84 |

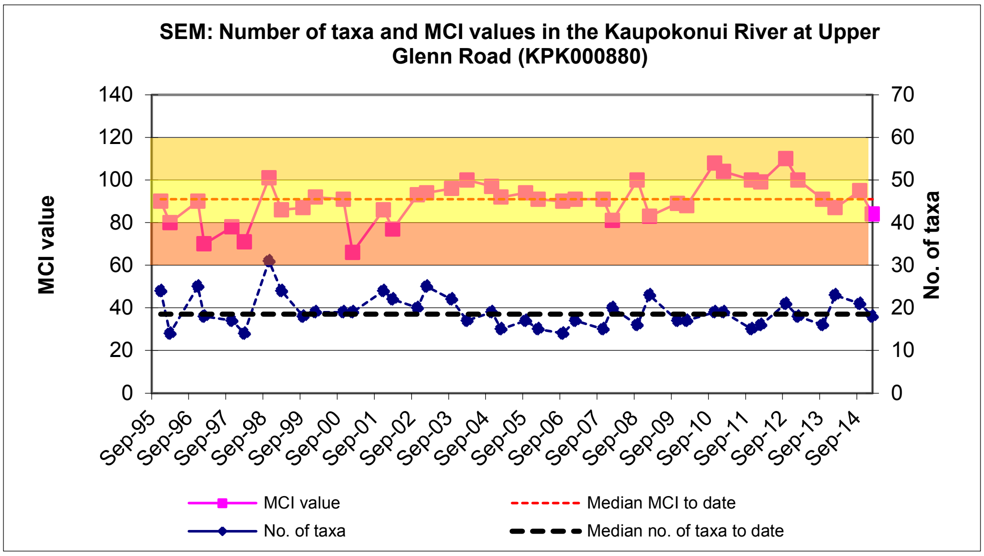



**Figure 86** Numbers of taxa and MCI values in Kaupokonui River at Upper Glenn Road

A wide range of richnesses (14 to 31 taxa) has been found with a median richness of 19 taxa (typical of richnesses in the lower reaches of ringplain streams and rivers). During the 2014-2015 period spring (21 taxa) and summer (18 taxa) richnesses were relatively similar and within two taxa of the median taxa number.

MCI values have had a very wide range (44 units) at this site, more typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been slightly lower than typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (95 units) and summer, 2015 (84 units) scores were significantly different and four units higher (spring) and seven units lower (summer) than the historical median score at this site coincident with patchy spring substrate periphyton cover and more widespread filamentous algae cover in summer. These scores categorised this site has having 'fair' health (spring and summer) generically (Table 1) and, in terms of predictive relationships (Table 2) 'expected' (spring and summer) health for the lower reaches of a ringplain river. The historical median score (91 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

### 3.2.19.4.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [38 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **PLATYHELMINTHES** | *Cura* | 3 | 1 | 3 | | |
| **NEMERTEA** | Nemertea | 3 | 6 | 16 | | |
| **ANNELIDA** | Oligochaeta | 1 | 32 | 84 | A | A |
| **MOLLUSCA** | *Latia* | 5 | 1 | 3 | | |
| | *Physa* | 3 | 2 | 5 | | |
| | *Potamopyrgus* | 4 | 12 | 32 | | VA |
| **CRUSTACEA** | Ostracoda | 1 | 1 | 3 | | |
| | *Paracalliope* | 5 | 1 | 3 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 1 | 3 | | |
| | *Coloburiscus* | 7 | 3 | 8 | | |
| | *Deleatidium* | 8 | 20 | 53 | VA | |
| | *Nesameletus* | 9 | 1 | 3 | | |
| **COLEOPTERA** | Elmidae | 6 | 28 | 74 | | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 4 | 11 | | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 66 | | |
| | *Costachorema* | 7 | 3 | 8 | | |
| | *Hydrobiosis* | 5 | 21 | 55 | A | A |
| | *Oxyethira* | 2 | 6 | 16 | | A |
| | *Pycnocentrodes* | 5 | 18 | 47 | VA | VA |
| **DIPTERA** | *Aphrophila* | 5 | 7 | 18 | | |
| | *Chironomus* | 1 | 1 | 3 | | |
| | *Maoridiamesa* | 3 | 23 | 61 | VA | |
| | Orthocladiinae | 2 | 35 | 92 | A | VA |
| | Tanytarsini | 3 | 5 | 13 | | A |
| | Ephydridae | 4 | 1 | 3 | | |
| | Muscidae | 3 | 2 | 5 | | |
| | *Austrosimulium* | 3 | 2 | 5 | | |

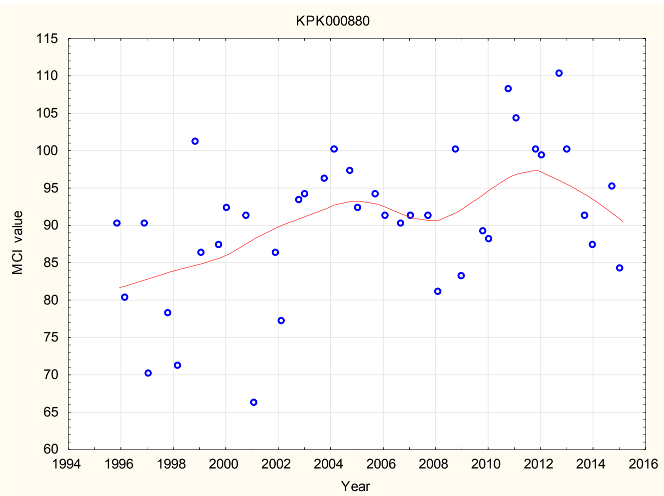
Prior to the current 2014-2015 period, 27 taxa had characterised the community at this site on occasions. These have comprised two 'highly sensitive', ten 'moderately sensitive', and fifteen 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; two 'moderately sensitive' taxa [elmid beetles and caddisfly (*Hydrobiosis*)]; and four 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. Six of the historically characteristic taxa (all of which have been predominant) were dominant in the spring, 2014 community. These comprised one 'highly sensitive', two 'moderately sensitive', and three 'tolerant' taxa, whereas four of these taxa (two 'moderately sensitive', and two 'tolerant' taxa) together with one 'moderately sensitive' and three 'tolerant' additional taxa, and one fewer 'highly sensitive' and one fewer 'tolerant' taxa, comprised the dominant taxa of the summer, 2015 community. Only four of these ten taxa were dominant in both spring and summer communities (Table 91). The proportional increase in summer dominance by a few of the 'tolerant' taxa and decrease in abundance of the single 'highly sensitive' mayfly taxon in particular were reflected in the decrease of 1.2 units in seasonal $SQMCI_s$ scores (Tables 162 and 163). The five taxa recorded as very abundant during spring and/or summer have characterised this site's communities on 32% to 92% 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 (91) is equal with the altitude prediction and four units lower than the predictive distance value. The spring, 2014 score (95 units) was similar to (equal to 4 units above) predictive values and the summer, 2015 score (84 units) seven to a significant 11 units below both predictive values. Of the 40 surveys to date at this site, 48% of MCI scores have been less than 91 units while only 28% have been greater than 95 units.

### 3.2.19.4.4 Temporal trends in 1995 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 40
Kendall tau = +0.272
p level = 0.013 [>FDR, p = 0.025]
Significant at $p < 0.05$ but not significant at $p < 0.01$ nor after FDR application at $p < 0.01$

**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, steady improvement until 2012, then a gradual decline with the overall twenty-year trend statistically significant ($p<0.05$ after FDR) but not significant at $p < 0.01$ after FDR application. The LOWESS-smoothed range of MCI scores (15 units) has been ecologically important but nowhere near as wide as that upstream, also indicative of some decrease in 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) through the period, and more recently some individual scores indicated 'good' health 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 'worse than expected' (prior to 1998) to the 'expected' category where it has remained.

### 3.2.19.5 Kaupokonui Beach site (KPK000990)

#### 3.2.19.5.1 Taxa richness and MCI

Thirty surveys have been undertaken in the Kaupokonui River at this lower reach site at Kaupokonui Beach between 1999 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1999 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KPK000990 | 30 | 11-26 | 19 | 69-103 | 91 | 19 | 100 | 18 | 83 |

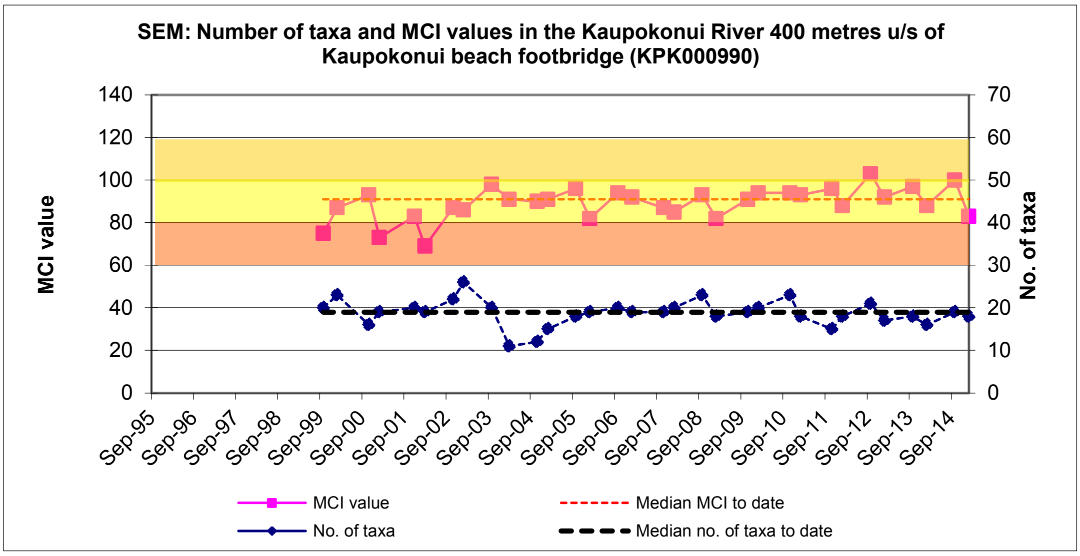



**Figure 88** Numbers of taxa and MCI values in the Kaupokonui River at the Kaupokonui Beach site

A wide range of richnesses (11 to 26 taxa) has been found, with a median richness of 19 taxa. During the 2014-2015 period spring (19 taxa) and summer (18 taxa) richnesses were similar and within one taxon of the median richness.

MCI values have had a moderate range (34 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (100 units) score was nine units higher than the median while the summer, 2015 (83 units) score was typical for such a site in summer and eight units below 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' (spring) and 'expected' (summer) health for the lower reaches of a ringplain river. The historical median score (91 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

### 3.2.19.5.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 period are listed in Table 93.

**Table 93** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Kaupokonui River at the Kaupokonui Beach site between 1999 and February 2014 [30 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 3 | 10 | | A |
| **ANNELIDA** | Oligochaeta | 1 | 28 | 93 | A | A |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 15 | 50 | A | VA |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 2 | 7 | | |
| | *Coloburiscus* | 7 | 1 | 3 | | |
| | *Deleatidium* | 8 | 21 | 70 | VA | |
| **COLEOPTERA** | Elmidae | 6 | 18 | 60 | | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 19 | 63 | | A |
| | *Costachorema* | 7 | 3 | 10 | | |
| | *Hydrobiosis* | 5 | 18 | 60 | | A |
| | *Pycnocentrodes* | 5 | 19 | 63 | XA | A |
| **DIPTERA** | *Aphrophila* | 5 | 2 | 7 | | |
| | *Maoridiamesa* | 3 | 20 | 67 | VA | |
| | Orthocladiinae | 2 | 28 | 93 | A | XA |
| | Tanytarsini | 3 | 9 | 30 | | A |
| | Muscidae | 3 | 1 | 3 | | |

Prior to the current 2014-2015 period, 16 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', seven 'moderately sensitive', and eight 'tolerant' taxa i.e. a very low proportion of 'highly sensitive' taxa and a higher proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; three 'moderately sensitive' taxa [elmid beetles, free-living caddisfly (*Hydrobiosis*), and stony-cased caddisfly (*Pycnocentrodes*)]; and five 'tolerant' taxa [oligochaete worms, snail (*Potamopygus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)].

Six of the historically characteristic taxa were dominant in the spring, 2014 community, all of which have been predominant to date. These comprised one 'highly sensitive' taxon, one 'moderately sensitive' taxon, and four 'tolerant' taxa.

Four of these taxa together with an additional one 'moderately sensitive' and three 'tolerant' taxa and one fewer 'highly sensitive' and one 'tolerant' taxa comprised the dominant taxa of the summer, 2015 community. Therefore, four of these ten taxa were dominant in both spring and summer communities (Table 93). A significant decrease in numerical abundances in two 'sensitive' taxa and increases in several 'tolerant' taxa abundances were reflected in the large summer decrease of 2.4 units in $SQMCI_s$ score (Tables 162 and 163).

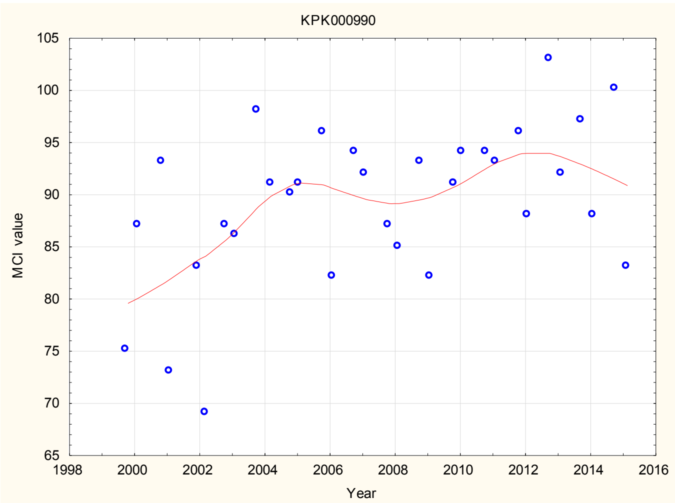
The five taxa recorded as very or extremely abundant during spring and/or summer have characterised this site's communities on 50% to 93% of past survey occasions.

#### 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 (91) is six units higher than the altitude and two units below the distance predictive values. The spring 2014 survey score (100 units) was seven to a significant 15 units above the predictive values while the summer score (83 units) was two units lower than the predictive altitude value and 10 units below the distance value. Of the 32 surveys to date at this site, 22% of MCI scores have been less than 85 units while only 28% have been greater than 93 units.

#### 3.2.19.5.4 Temporal trends in 1999 to 2015 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 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 = 32
Kendall tau = +0.322
p level = 0.009 [>FDR, p = 0.020]
Significant at $p < 0.05$ and $p < 0.01$
N/S after FDR at $p < 0.01$

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

Although the sixteen year trend in MCI scores has indicated improvement, the overall temporal trend has not been statistically significant ($p > 0.01$ after FDR), unlike trends further upstream which have a slightly (four year) longer monitoring period, with poorer 'health' prior to 1999. More recently (since 2012) smoothed scores have plateaued with a most recent declining trend. However, an ecologically important range of LOWESS-smoothed scores (14 units) has been recorded, although much narrower than ranges at the two nearest upstream sites, possibly reflecting certain upstream improvements in waste disposal management (documented earlier) which have had reduced impacts with greater distance downstream.

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 relatively 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 remained in the 'expected' category over the entire period, after bordering on the 'worse than expected' category early in the period.

### 3.2.19.6 Discussion

Seasonal MCI values typically decreased between spring and summer at all but the upper of the five sites; from the Kaponga site (by 14 units), Kapunui railbridge site (nine units), the Upper Glen Road site (11 units), to the Kaupokonui Beach site (17 units); but not at the upper mid-reach site where there was no seasonal change. These seasonal differences may be compared with historical seasonal median decreases of two, 10, four, five, and six units respectively (Appendix II). Seasonal communities shared 58% of 33 taxa at the Opunake Road upper mid-reach site, 60% of 30 taxa at the Kaponga mid-reach site, 53% of 32 taxa at the Kapuni Railbridge mid-reach site, 50% of 26 taxa at the Upper Glenn Road lower reach site, and 54% of 24 taxa at the furthest downstream site (Kaupokonui Beach) in the lower reaches. Seasonal community compositions have generally been more variable with increasing distance downstream from the National Park, particularly in the lower reaches, and this trend generally was apparent during the 2014-2015 monitoring period. Lesser variability occurred in the mid reaches where there was less than 45% dissimilarity in seasonal community composition.

Community composition varied markedly through the length of the river surveyed. A total of 45 taxa was recorded in spring of which only eight taxa (18%) were present at all five sites. These included one 'highly sensitive' taxon, six 'moderately sensitive' taxa, and one 'tolerant' taxon with only the 'highly sensitive' mayfly (*Deleatidium*), abundant at all five sites. A slightly lower number of taxa (41) was found along the river's length by the summer survey of which only seven taxa (17%) were present at all five sites. These were similar to the eight widespread taxa in spring with the overall loss of one 'moderately sensitive taxon'. No taxa were abundant at all five sites. These dissimilarities in spatial community structure along the length of the Kaupokonui River were only very slightly more pronounced in summer than in spring.

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 56 units in summer, over a river distance of 27.8 km. These seasonal falls in MCI scores equated to average rates of decline of 1.4 units/km (spring) and 2.0 units/km (summer), compared with the predicted average rate of 0.9 unit/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 most past summers' seasonal increases in average rates of decline. This may be compared with an average rate of 0.6 unit/km derived for the nearby Waingongoro River (over the 20 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 (2.5 units/km) and summer (3.2 unit/km) average rates of decline were dissimilar but well above the predicted average rate (1.4 units/km) for the equivalent river reach. For the mid-reach Kapuni site to Kaupokonui Beach lower reach site, spring (0.6 unit/km) and summer (1.1 units/km) average rates of decline were also dissimilar with both rates above the predicted average rate of 0.5 unit/km, particularly in summer.

Using the long-term median SEM MCI scores for each site (Appendix II), the average 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 average rate of decline of 1.4 MCI units/km over the river's length. Spring and summer overall average rates of decline have been 1.3 and 1.4 units per kilometre. Therefore overall average rates of decline for the 2014-2015 period were very similar in both spring (within 0.1 unit/km) but much greater in summer from the historical median average rates prior to 2014.

## 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 2014-2015 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

Thirty surveys have been undertaken at this upper reach site in the Katikara Stream inside the National park boundary at Carrington Road between September 1999 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to February 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KTK000150 | 30 | 11-38 | 29 | 112-148 | 137 | 21 | 135 | 31 | 130 |

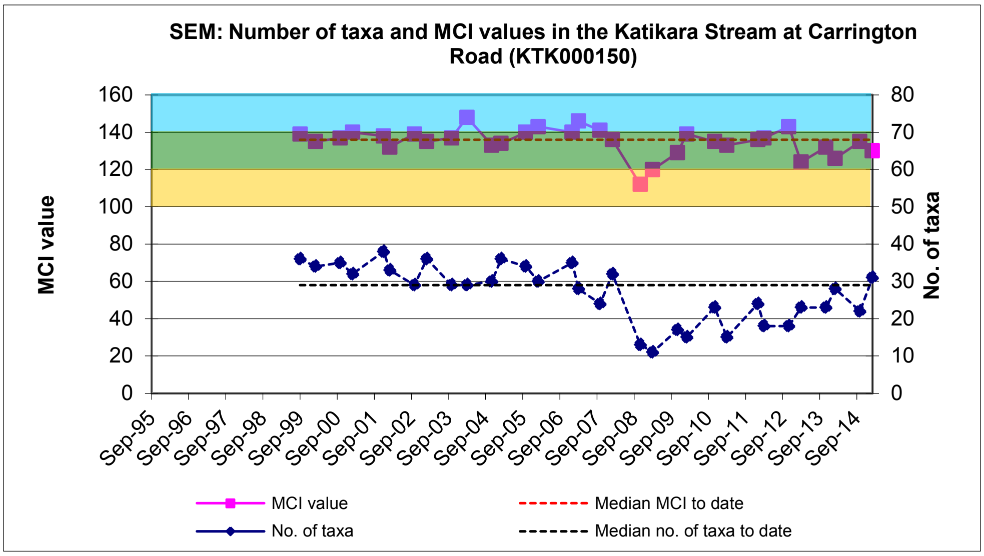



**Figure 90** Numbers of taxa and MCI values in the Katikara Stream at Carrington Road

A very wide range of richnesses (11 to 38 taxa) has been found; wider than might be expected, due to the impacts of significant headwater erosion over the 2008-2009 period and subsequent recovery from these effects. The median richness of 29 taxa has been far more representative of typical richnesses in ringplain streams and rivers near the National Park boundary (TRC, 2015a), although median richness since the 2008-2009 erosion event has been 20 taxa (Figure 90). During the 2014-2015 period spring (22 taxa) richness was well below the long term median richness indicative of a continuing post-headwater erosion recovery phase and/or long term degradation of the physical habitat, while the summer richness (31 taxa) was slightly above the long term median but still below the majority of pre-erosion richnesses (Figure 90).

MCI values at this site have had a wider range (36 units) than typical of a National Park boundary site, due in part to atypically lower values for a short period and on other isolated occasions since the 2008-2009 headwater erosion event. The median value (137 units) has been typical of upper reach sites (near or within the National Park) elsewhere on the ringplain (TRC, 2015a) however, with the spring, 2014 (135 units) score within the typical range for such a site and two units below the historical median. The summer score (130 units) was an insignificant seven units lower than the historical median, coincident with low flow conditions and limited riffle 'habitat' at this site where patchy filamentous algae was also present. These scores categorised this site as having 'very good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health for the upper reaches of a ringplain stream in spring and in summer although taxa numbers in general continued to be slightly lower than typical pre-erosion richnesses. The historical median score (137 units) placed this site in the 'very good' category for the generic, and '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 2014-2015 period are listed in Table 95.

**Table 95** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Katikara Stream at Carrington Road between 1999 and February 2014 [30 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **EPHEMEROPTERA** | *Ameletopsis* | 10 | 1 | 3 | | |
| | *Austroclima* | 7 | 15 | 50 | | |
| | *Coloburiscus* | 7 | 22 | 73 | A | A |
| | *Deleatidium* | 8 | 27 | 90 | VA | A |
| | *Nesameletus* | 9 | 19 | 63 | A | |
| **PLECOPTERA** | *Acroperla* | 5 | 2 | 7 | | |
| | *Austroperla* | 9 | 6 | 20 | | A |
| | *Zelandobius* | 5 | 19 | 63 | A | |
| | *Zelandoperla* | 8 | 16 | 53 | VA | |
| **COLEOPTERA** | Elmidae | 6 | 7 | 23 | | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 2 | 7 | | |
| **TRICHOPTERA** | *Costachorema* | 7 | 1 | 3 | | |
| | *Hydrobiosis* | 5 | 1 | 3 | | |
| | *Hydrobiosella* | 9 | 7 | 23 | | |
| | *Hydropsyche (Orthopsyche)* | 9 | 8 | 27 | | |
| | *Beraeoptera* | 8 | 1 | 3 | | |
| | *Oxyethira* | 2 | 1 | 3 | | |
| **DIPTERA** | *Aphrophila* | 5 | 5 | 17 | | |
| | Orthocladiinae | 2 | 15 | 50 | A | |
| | *Polypedilum* | 3 | 1 | 3 | | |

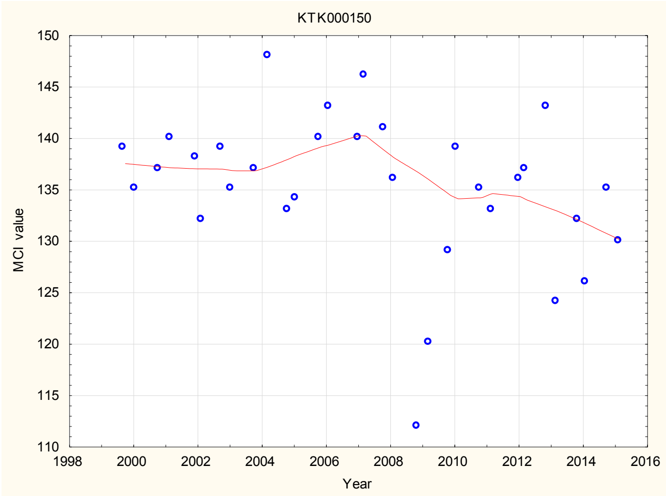
Prior to the current 2014-2015 period, 20 taxa had characterised the community at this site on occasions. These have comprised eight 'highly sensitive', nine 'moderately sensitive', and three 'tolerant' taxa i.e a majority of 'sensitive' taxa as would be expected near the National Park boundary of a ringplain stream. Predominant taxa have included three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*) and stonefly (*Zelandoperla*)]; three 'moderately sensitive' taxa [mayflies (*Coloburiscus* and *Austroclima*), and stonefly (*Zelandobius*)]; and one 'tolerant' taxon [orthoclad midges]. Six of these predominant characteristic taxa (three 'highly sensitive', two 'moderately sensitive', and one 'tolerant' taxa) were dominant in the spring, 2014 community. Only two of these taxa were dominant in the summer, 2015 community together with one other 'highly sensitive' historically characteristic taxon. Almost entirely 'sensitive' taxa were dominant coincident with patchy periphyton substrate cover (mats or filaments) at this site on each occasion. Despite some changes in these characteristic community compositions between seasons, seasonal $SQMCI_s$ values varied by only 0.3 unit (Tables 164 and 165) due to numerical dominance mainly by 'highly sensitive' taxa on both occasions resulting in high scores (7.3 and 7.0 units). The taxa recorded as very or extremely abundant at the time of spring and/or summer surveys had characterised this site's communities on 53% to 90% 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 (137 units) is 10 units higher than the altitude prediction and five units higher than the distance predictive value. The spring score (135 units) was three to eight units higher than both predictive scores while the summer score (130 units) was two units lower to three units higher than predictive scores. Of the 32 surveys to date at this site, only 13% of MCI scores have been less than 127 units while 81% have been greater than 132 units.

#### 3.2.20.1.4 Temporal trends in 1999 to 2015 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 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 = 32
Kendall tau = - 0.224
p level = 0.071 [>FDR, p = 0.122]
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 subsequent downward trend has been due to significant headwater erosion effects during 2008, and limited recovery after 2010. Although, the overall temporal trend of deterioration has not been statistically significant (p = 0.07), the range of LOWESS-smoothed scores (10 units) over the period has been of marginal ecological importance with the range having widened appreciably since the erosion event. However, smoothed scores have remained indicative of 'very good' generic stream health (Table 1) throughout the period, bordering on 'excellent' in the 2006-2007 period. 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 in the 'expected' category throughout the period, bordering on the 'better than expected' category just prior to the headwater erosion impacts during 2008.

### 3.2.20.2 Coastal site (KTK000248)

#### 3.2.20.2.1 Taxa richness and MCI

Twenty-eight surveys have been undertaken in the Katikara Stream at this lower reach site near the coast between October 2000 and February 2014. 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 2014 and summer 2015

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KTK000248 | 28 | 20-31 | 26 | 87-118 | 102 | 25 | 90 | 24 | 93 |

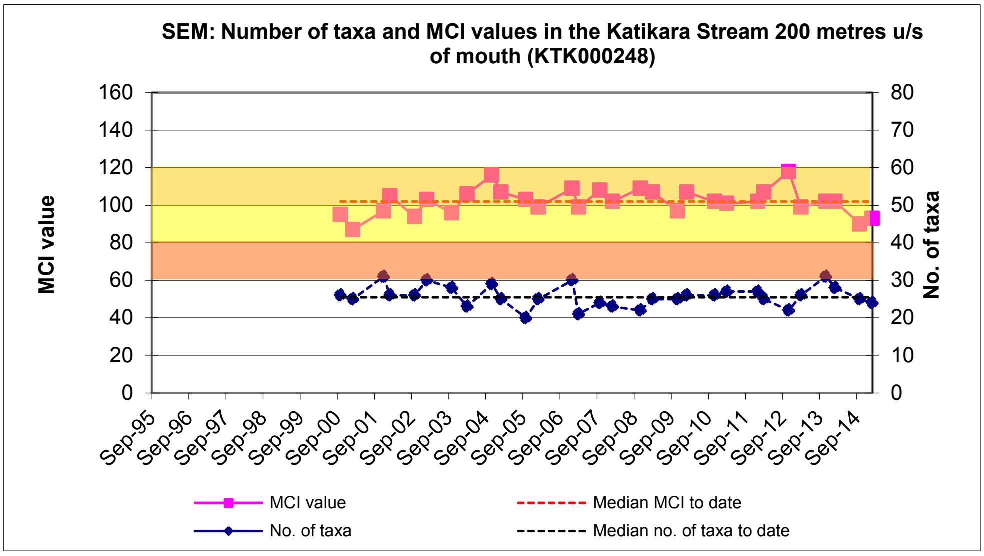



**Figure 92** Numbers of taxa and MCI values in the Katikara Stream 200m u/s of the coast

A moderate range of richnesses (20 to 31 taxa) has been found with no obvious indication of the severe effects of headwater erosion events that have been noted at the upstream site. The median richness of 26 taxa has been more representative of typical richnesses elsewhere in the lower reaches of ringplain streams and rivers (TRC, 2015a). During the 2014-2015 period, spring (25 taxa) and summer (24 taxa) richnesses were very similar and within two taxa of the median taxa number.

MCI values have had a relatively wide range (31 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (102 units) has been higher than typical of lower reach sites elsewhere on the ringplain however (TRC, 2015a), with the spring, 2014 score (90 units) and summer score (93 units) both below the historical median (by a significant 12 to 9 units respectively) coincident with some increase in periphyton substrate cover in summer. 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 summer) health for the lower reaches of a ringplain stream. The historical median score (102 units) placed this site in the 'good' category for the generic and '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 2014-2015 period are listed in Table 97.

**Table 97** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Katikara Stream near the mouth between October 2000 and February 2014 [28 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 3 | 11 | | |
| **ANNELIDA** | Oligochaeta | 1 | 18 | 64 | VA | VA |
| **MOLLUSCA** | *Latia* | 5 | 2 | 7 | | |
| | *Potamopyrgus* | 4 | 24 | 86 | VA | VA |
| **CRUSTACEA** | *Paratya* | 3 | 1 | 4 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 17 | 61 | | |
| | *Coloburiscus* | 7 | 13 | 46 | | |
| | *Deleatidium* | 8 | 19 | 68 | A | |
| | *Rallidens* | 9 | 1 | 4 | | |
| **PLECOPTERA** | *Zelandobius* | 5 | 1 | 4 | A | |
| | *Zelandoperla* | 8 | 1 | 4 | | |
| **COLEOPTERA** | Elmidae | 6 | 25 | 89 | VA | A |
| | Ptilodactylidae | 8 | 2 | 7 | | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 16 | 57 | VA | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 89 | VA | A |
| | *Costachorema* | 7 | 7 | 25 | | |
| | *Hydrobiosis* | 5 | 19 | 68 | A | A |
| | *Pycnocentrodes* | 5 | 24 | 86 | VA | A |
| **DIPTERA** | *Aphrophila* | 5 | 19 | 68 | | |
| | *Maoridiamesa* | 3 | 9 | 32 | | |
| | Orthocladiinae | 2 | 21 | 75 | A | VA |
| | Tanytarsini | 3 | 4 | 14 | | |
| | *Austrosimulium* | 3 | 8 | 29 | A | A |

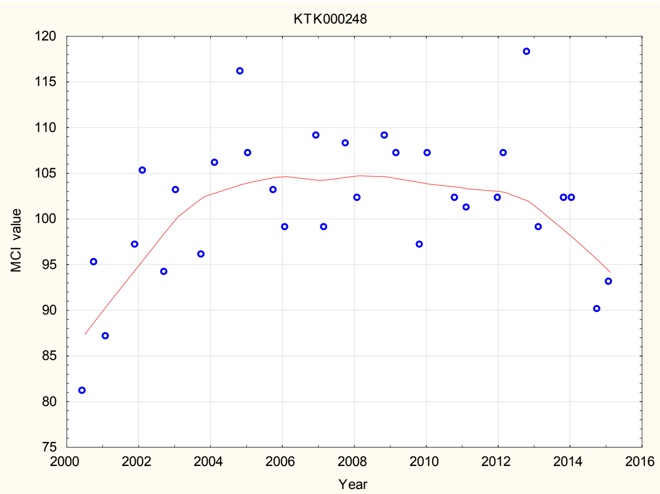
Prior to the current 2014-2015 period, 23 taxa had characterised the community at this site on occasions. These have comprised four 'highly sensitive', ten 'moderately sensitive', and nine 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and an increased proportion of 'tolerant' taxa as would be expected in the lower reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; six 'moderately sensitive' taxa [mayfly (*Austroclima*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisfly (*Hydrobiosis*), stony-cased caddisfly (*Pycnocentrodes*), and cranefly (*Aphrophila*)]; and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges]. Eleven of the historically characteristic taxa were dominant in the spring, 2014 community comprising one 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa; whereas nine of these taxa (two fewer 'sensitive' taxa) comprised the dominant taxa of the summer community. Nine of these 11 characteristic taxa therefore were dominant in both spring and summer communities (Table 97) but an increase in numerical abundances in one 'tolerant' taxon and decreases in abundance within one 'highly sensitive' and four 'moderately sensitive' taxa were reflected in the seasonal decrease in $SQMCI_s$ score (Table 164 and 165) which was lower by 1.3 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 89% 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 (102) is a significant 17 units higher than the altitude prediction and three units higher than the distance predictive value. The spring score (90 units) and summer score (93 units) were higher than the predictive altitude value but six to nine units below the predictive distance value. Of the 30 surveys to date at this site, no MCI scores have been less than 85 units while 63% have been greater than 99 units, confirmation of the 'better than expected' stream health found from time to time at this site.

### 3.2.20.2.4 Temporal trends in 2000 to 2015 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 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 = 31
Kendall tau = +0.117
p level = 0.356 [>FDR, p = 0.463]
N/S at p <0.05;

**Figure 93** LOWESS trend plot of MCI data at the coastal site

A relatively strong temporal improvement in MCI scores has been recorded, during the first five years of the fifteen year monitoring period with an eight-year period of relatively stable scores followed by some recent deterioration. Whereas previously the overall improving trend was statistically significant, it now has no statistical significance at $p > 0.05$. The wide range of LOWESS-smoothed MCI scores (18 units) has particular ecological importance 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 remained until a return to 'fair' health most recently (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' category where it has remained since 2003 until very recently.

#### 3.2.20.3 Discussion

Seasonal MCI values decreased but only by five units between spring and summer at the National Park site but atypically increased (by three units) between spring and summer at the coastal site with the percentage composition of 'tolerant' taxa atypically remaining very similar in the summer communities at both sites (within 2%). Seasonal median scores (Appendix II) have remained very similar at the National Park site (within 2 units) and at the coastal site (identical); an atypical seasonal trend compared with lower reach sites elsewhere on the ringplain. Seasonal communities at the upper site shared 21 common taxa (66% of the 32 taxa found at this site in 2014-2015) compared with 19 shared common taxa (63% of the 30 taxa) at the lower reaches site near the coast; a typically slightly more pronounced seasonal change in community composition at the downstream site coincidental with increased periphyton cover under summer lower flow conditions. The two sites shared only 9 common taxa (24% of the 38 taxa in total found at upper and lower reach sites) in spring and only 11 common taxa (25% of 44 taxa) in summer, indicative of minimal change in dissimilarities in spatial community structures between spring and summer.

MCI score typically fell in a downstream direction in spring (by 45 units) and to an atypically lesser degree in summer (by 37 units), over a stream distance of 18.1 km downstream from the National Park boundary. These falls equated to average rates of decline of 2.5 units/km in spring and 2.0 units/km in summer, slightly higher than the predicted average 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 average 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 average rates of MCI decline over the 2014-2015 period were also higher in both spring and summer than the long term average median rate for the 1995 to 2014 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, 2014 and summer, 2014-2015 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

Thirty surveys have been undertaken in the Kapoaiaia Stream between March 1998 and February 2014 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KPA000250 | 30 | 19-31 | 25 | 83-130 | 111 | 24 | 121 | 25 | 118 |

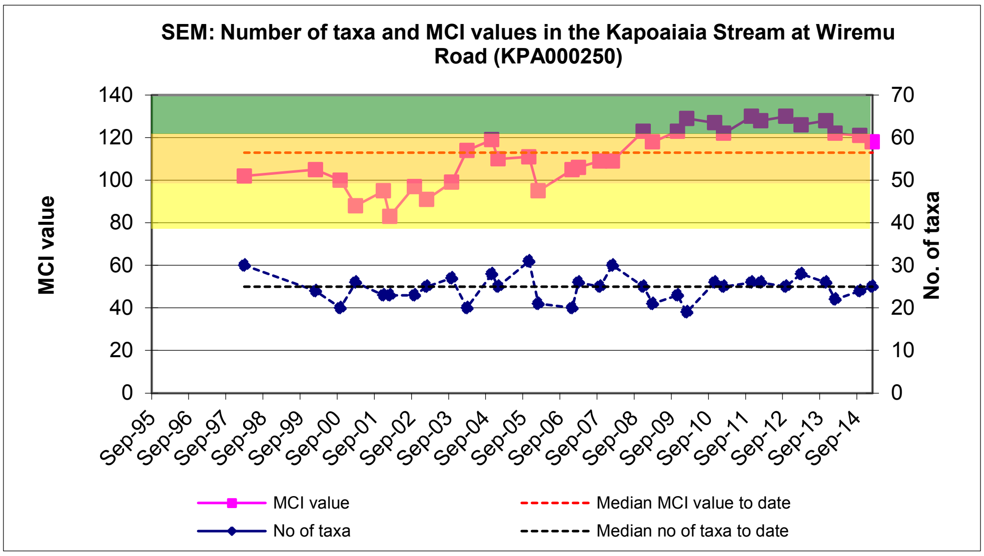



**Figure 94** Numbers of taxa MCI values in the Kapoaiaia Stream at Wiremu Road

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 2014-2015 period, spring (24 taxa) and summer (25 taxa) richnesses were very similar and within one taxon of this median richness.

MCI values have had a wide range (47 units) at this site, wider than typical of a site in the upper mid-reaches of a ringplain stream although this site is in a reach of very open farmland, nearly 6km downstream from the National Park boundary. The median value (111 units) has been slightly lower than typical of upper mid-reach sites elsewhere on the ringplain. The spring, 2014 (121 units) and summer, 2015 (118 units) scores were insignificantly 10 and seven units above the historical median respectively. These scores categorised this site as having 'very good' generic health (Table 1) in spring and 'good' health in summer and in terms of predictive relationships (Table 2), 'expected' health for the upper mid-reaches of a ringplain stream on both of these occasions. The historical median score (111 units) placed this site in the 'good' and '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 2014-2015 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 2014 [30 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| ANNELIDA | Oligochaeta | 1 | 12 | 40 | | |
| MOLLUSCA | *Potamopyrgus* | 4 | 3 | 10 | | |
| CRUSTACEA | *Paracalliope* | 5 | 1 | 3 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 7 | 23 | | |
| | *Coloburiscus* | 7 | 20 | 67 | VA | VA |
| | *Deleatidium* | 8 | 22 | 73 | XA | XA |
| | *Nesameletus* | 9 | 11 | 37 | | |
| PLECOPTERA | *Acroperla* | 5 | 6 | 20 | | |
| | *Zelandoperla* | 8 | 11 | 37 | A | |
| COLEOPTERA | Elmidae | 6 | 28 | 93 | A | VA |
| | Hydraenidae | 8 | 1 | 3 | | |
| MEGALOPTERA | *Archichauliodes* | 7 | 5 | 17 | | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 83 | | XA |
| | *Costachorema* | 7 | 16 | 53 | | A |
| | *Hydrobiosis* | 5 | 9 | 30 | | A |
| | *Beraeoptera* | 8 | 7 | 23 | | |
| | *Helicopsyche* | 10 | 2 | 7 | | |
| | *Olinga* | 9 | 1 | 3 | | |
| | *Oxyethira* | 2 | 4 | 13 | | |
| | *Pycnocentrodes* | 5 | 9 | 30 | | |
| DIPTERA | *Aphrophila* | 5 | 22 | 73 | | A |
| | Eriopterini | 5 | 1 | 3 | | |
| | *Maoridiamesa* | 3 | 21 | 70 | | VA |
| | Orthocladiinae | 2 | 23 | 77 | | VA |
| | Tanytarsini | 3 | 2 | 7 | | |
| | Muscidae | 3 | 3 | 10 | | |
| | *Austrosimulium* | 3 | 5 | 17 | | |

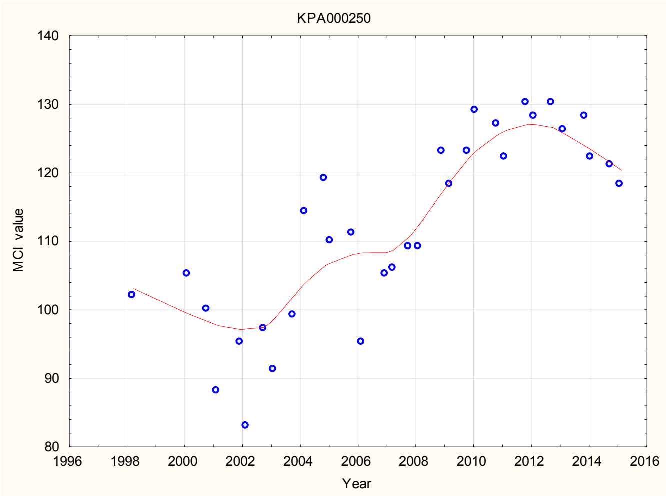
Prior to the current 2014-2015 period, a high number of taxa (27) had characterised the community at this site on occasions. These have comprised seven 'highly sensitive', eleven 'moderately sensitive', and nine 'tolerant' taxa i.e. a predominance of 'sensitive' taxa as would be expected in the upper mid-reaches of a ringplain stream but also a relatively higher number of 'tolerant' taxa for a site within 6km of the National Park boundary. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, free-living caddisfly (*Costachorema*), and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [net-building caddisfly (*Hydropsyche-Aoteapsyche*) and midges (orthoclads and *Maoridiamesa*)]. Three of these predominant taxa were dominant in the spring, 2014 community together with only one other 'highly sensitive' taxon. The summer, 2015 community was characterised by three of the taxa dominant in spring, together with an additional four 'moderately sensitive' taxa and three 'tolerant' taxa and one fewer 'highly sensitive' taxon, all of which had been characteristic of this site's communities previously (Table 99). Despite the differences between the seasonally most dominant taxa compositions there was minimal change in $SQMCI_s$ scores (0.1 unit) between spring and summer (Tables 166 and 167). Taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 67% to 93% of the past surveys.

#### 3.2.21.1.3 Predicted stream 'health'

The Kapoaiaia Stream site at Wiremu Road is 5.7 km downstream of the National Park boundary at an altitude of 240 m asl. Relationships for ringplain streams developed between MCI and site altitude and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 109 (altitude) and 112 (distance) for this site. The historical site median (111 units) is two units above the altitude prediction and one unit lower than the distance predictive values. However, the spring, 2014 survey score (121 units) was significantly (Stark, 1998) 12 units higher than the altitude value but nine units above the distance value while the summer, 2015 score (118 units) was six to nine units higher than these predictive values. Of the 32 surveys to date at this site, 38% of MCI scores have been less than 109 units while 50% have been greater than 112 units. The scores recorded in the 2014-2015 period were better than the majority of previous scores.

#### 3.2.21.1.4 Temporal trends 1995 to 2015

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 = 32
Kendall tau = +0.573
p level < 0.0001 [>FDR, p < 0.001]
Significant at p <0.01 and after FDR application

**Figure 95** LOWESS trend plot of MCI data at the Wiremu Road site

A statistically very significant temporal trend of improvement in MCI scores has been found over the seventeen year duration of this monitoring period (particularly over the period since 2003) which was significant at p<0.01 after FDR application. There has been an ecologically important variability in the extremely wide (30 units) range of LOWESS-smoothed scores at this site also. This appears to have been related to farming practices, particularly variations in fertiliser usage, through the open reach between the National Park boundary and this upper site, which may have been exacerbated by the lack of riparian vegetation along this reach.

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 6 km below the National Park. A strong improvement has been obvious between 2007 and 2012 when it plateaued with some deterioration in 'health' over the 2013 to 2015 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 'worse than expected' category prior to 2004 improving to 'expected' until 2010 and most recently to the 'better than expected' category.

### 3.2.21.2 Wataroa Road site (KPA000700)

#### 3.2.21.2.1 Taxa richness and MCI

Thirty surveys have been undertaken in the Kapoaiaia Stream at this mid-reach site at Wataroa Road between December 1996 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KPA000700 | 30 | 12-30 | 21 | 78-118 | 95 | 21 | 95 | 19 | 85 |

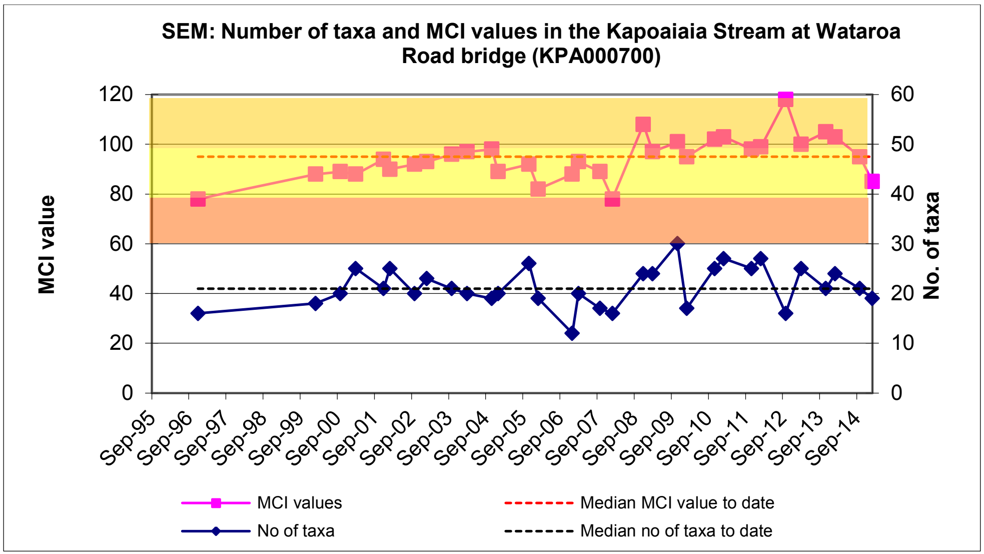



**Figure 96** Numbers of taxa and MCI values in the Kapoaiaia Stream at Wataroa Road

A wide range of richnesses (12 to 30 taxa) has been found, with a median richness of 21 taxa, relatively typical of richnesses in the mid-reaches of ringplain streams and rivers. During the 2014-2015 period, spring (21 taxa) and summer (19 taxa) richnesses were relatively similar and equivalent with the median taxa number in spring and below the median richness in summer; with the latter being coincident with more widespread substrate periphyton mats cover. MCI values have had a relatively wide range (40 units) at this site, more so than typical of many sites in the mid-reaches of ringplain rivers. The historical median value (95 units) is lower than values typical of mid-reach sites elsewhere on the ringplain however (TRC, 2015a). The spring, 2014 (95 units) and summer, 2015 (85 units) scores were equal with the historical median score and lower by ten units respectively. These scores categorised this site as having 'fair' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' (spring) and 'worse than expected' (summer) health for the mid-reaches of a ringplain river. The historical median score (95 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

### 3.2.21.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 period are listed in Table 101.

**Table 101** Characte ristic taxa (abundant, very abundant, extremely abundant) recorded in the Kapoaiaia Stream at Wataroa Road between 1995 and February 2014 [30 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **PLATYHELMINTHES** | *Cura* | 3 | 1 | 3 | | |
| **NEMATODA** | Nematoda | 3 | 1 | 3 | | |
| **ANNELIDA** | Oligochaeta | 1 | 17 | 57 | | A |
| | Lumbricidae | 5 | 1 | 3 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 7 | 23 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 3 | 10 | | |
| | *Coloburiscus* | 7 | 5 | 17 | A | |
| | *Deleatidium* | 8 | 16 | 53 | VA | |
| | *Nesameletus* | 9 | 1 | 3 | | |
| **PLECOPTERA** | *Acroperla* | 5 | 2 | 7 | A | |
| | *Zelandobius* | 5 | 0 | 0 | A | |
| **COLEOPTERA** | Elmidae | 6 | 27 | 90 | A | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 10 | 33 | A | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 21 | 70 | A | A |
| | *Costachorema* | 7 | 15 | 50 | A | |
| | *Hydrobiosis* | 5 | 18 | 60 | A | |
| | *Oxyethira* | 2 | 2 | 7 | | |
| | *Pycnocentrodes* | 5 | 10 | 33 | A | |
| **DIPTERA** | *Aphrophila* | 5 | 16 | 53 | A | |
| | *Maoridiamesa* | 3 | 20 | 67 | VA | A |
| | Orthocladiinae | 2 | 26 | 87 | A | A |
| | Tanytarsini | 3 | 5 | 17 | A | |
| | Empididae | 3 | 4 | 13 | | A |
| | Muscidae | 3 | 4 | 13 | | |
| | *Austrosimulium* | 3 | 10 | 33 | | A |

Prior to the current 2014-2015 period, 24 taxa had characterised the community at this site on occasions. These have comprised two 'highly sensitive', ten 'moderately sensitive', and twelve 'tolerant' taxa i.e. a minority of 'highly sensitive' taxa and a downstream increase in the number of 'tolerant' taxa to a higher proportion than might be expected in the mid reaches of a ringplain stream. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [elmid beetles, free-living caddisflies (*Costachorema* and *Hydrobiosis*), and cranefly (*Aphrophila*)]; and four 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)]. Thirteen of the historically characteristic taxa were dominant in the spring, 2014 community; with one additional 'moderately sensitive' taxon [stonefly (*Zelandobius*)] not previously recorded in abundance at this site.These taxa comprised one 'highly sensitive', nine 'moderately sensitive', and four 'tolerant' taxa, whereas no 'highly sensitive', one 'moderately sensitive', and six 'tolerant' taxa comprised the dominant taxa of the summer community; a marked increase in the proportion of 'tolerant' taxa. However, only four of these seventeen taxa were dominant in both spring and summer communities (Table 101).The  decreased summer seasonal abundances within some 'moderately sensitive' taxa, and the 'highly sensitive' mayfly in particular were reflected in the decrease of 1.5 units in $SQMCI_s$ scores between spring and summer (Tables 166 and 167).

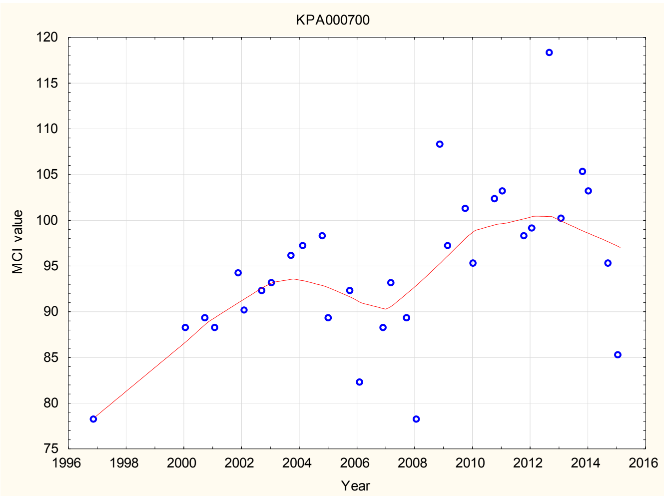
The two characteristic taxa found as very abundant by the seasonal surveys have characterised this site's communities on 53% to 67% of past survey occasions.

#### 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 (95) is four units lower than the altitude prediction and eight units lower than the distance predictive value. The spring, 2014 survey score (95 units) was four units lower than the predictive altitude value and eight units lower than the predictive distance value while the summer, 2015 score (85 units) was significantly (Stark, 1998) lower than both predictive values by 14 to 18 units. Of the 32 surveys to date at this site, 75% of MCI scores have been less than 99 units while only 13% have been greater than 103 units, confirmation of the much poorer than predicted historical biological 'health' at this site.

#### 3.2.21.2.4 Temporal trends in 1995 to 2015 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 = 32
Kendall tau = +0.423
p level < 0.001 [>FDR, p = 0.002]
Significant at p <0.01 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, these tended to decline between 2004 and 2007. Further more recent improvement has resulted in an overall eighteen year trend which has been statistically very significant (p< 0.01 after FDR). The range of

LOWESS-smoothed scores (22 units) has been ecologically important although it has been influenced by an initial very low score. From 2000 to date this range has been 12 units which also has ecological importance.This trend of improvement had been influenced probably by the same drivers of the marked improvement at the Wiremu Road site upstream.

Smoothed MCI scores have consistently indicated 'fair' generic stream health (Table 1) at this mid-catchment site, improving to 'good' briefly over the 2012-2013 period. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain stream health was in the 'worse than expected' category until 2001 and has been in the 'expected' category since then.

### 3.2.21.3 Upstream of coast site (KPA000950)

#### 3.2.21.3.1 Taxa richness and MCI

Thirty surveys have been undertaken at this lower reach site near the coast in the Kapoaiaia Stream between December 1996 and March 2013. 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 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KPA000950 | 30 | 15-24 | 19 | 76-101 | 86 | 25 | 88 | 18 | 84 |

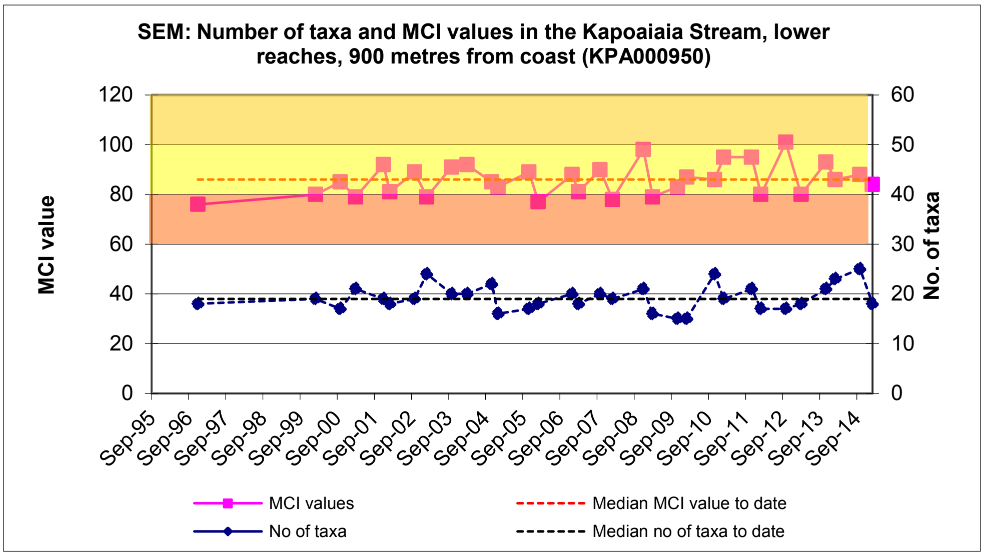



**Figure 98** Numbers of taxa and MCI values in the Kapoaiaia Stream at the Cape Egmont (upstream of coast) site

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 2014-2015 period, spring (25 taxa) and summer (18 taxa) richnesses were dissimilar  and above (by five taxa) the median taxa number in spring, and one taxon fewer than the median richness (summer), coincident with patchy spring and summer) substrate periphyton cover.

MCI scores have had a moderate range (25 units) at this site, slightly narrower than typical of sites in the lower reaches of ringplain streams. However, the median value (86 units) has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (88 units) score was typical for such a site and two units above the historical median for this site, whereas the summer, 2015 (84 units) score was two units below the historical median. These scores categorised this site as having 'fair' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' (spring and summer) health for the lower reaches of a ringplain stream. The historical median score (86 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 2014-2015 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 2014 [30 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **PLATYHELMINTHES** | *Cura* | 3 | 1 | 3 | | |
| **NEMERTEA** | Nemertea | 3 | 1 | 3 | | |
| **ANNELIDA** | Oligochaeta | 1 | 28 | 93 | A | |
| | Lumbricidae | 5 | 1 | 3 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 22 | 73 | A | A |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 2 | 7 | | |
| | *Deleatidium* | 8 | 3 | 10 | A | |
| **COLEOPTERA** | Elmidae | 6 | 18 | 60 | | |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 1 | 3 | A | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 83 | A | XA |
| | *Costachorema* | 7 | 2 | 7 | | |
| | *Hydrobiosis* | 5 | 21 | 70 | | A |
| | *Oxyethira* | 2 | 5 | 17 | | |
| | *Pycnocentrodes* | 5 | 16 | 53 | VA | A |
| **DIPTERA** | *Aphrophila* | 5 | 9 | 30 | | |
| | *Chironomus* | 1 | 1 | 3 | | |
| | *Maoridiamesa* | 3 | 18 | 60 | VA | |
| | Orthocladiinae | 2 | 29 | 97 | VA | VA |
| | Tanytarsini | 3 | 7 | 23 | | |
| | Empididae | 3 | 1 | 3 | | |
| | Muscidae | 3 | 4 | 13 | | |
| | *Austrosimulium* | 3 | 7 | 23 | | |

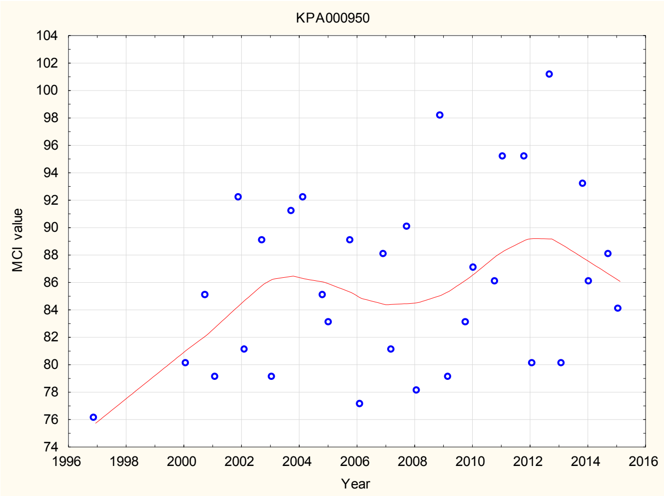
Prior to the current 2014-2015 period 22 taxa have characterised the community at this site on occasions. These have comprised one 'highly sensitive', eight 'moderately sensitive', and thirteen 'tolerant' taxa i.e. a high proportion of 'tolerant' taxa as might be expected in the lower reaches of a ringplain stream. Predominant taxa have included no 'highly sensitive' taxa; three 'moderately sensitive' taxa [elmid beetles, free-living caddisfly (*Hydrobiosis*), and stony-cased caddisfly (*Pycnocentrodes*)]; and five 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)]. Eight of the historically characteristic taxa were dominant in the spring 2014 community. These comprised one 'highly sensitive', two 'moderately sensitive', and five 'tolerant' taxa. Five of these taxa together with one additional 'moderately sensitive' taxon, comprised the dominant taxa in the summer community. Overall, five of these nine taxa were dominant in both spring and summer communities (Table 103). Despite an increase in seasonal proportional dominance by one 'tolerant' taxon in summer, a decrease in abundance within one 'tolerant' midge taxon contributed to a very small increase of 0.1 unit in seasonal $SQMCI_s$ scores (Table 166 and 167). The four taxa recorded as very/extremely abundant during spring and/or summer had characterised this site's communities on 53% to 97% of past survey occasions.

#### 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 (86 units) is equivalent with the altitude prediction but 10 units lower than the distance predictive value. The spring, 2014 survey score (88 units) was an insignificant one unit above the altitude predictive value and eight units less than the predictive distance value. The summer, 2015 score (84 units) was from two to a significant (Stark, 1998) 12 units lower than predictive values. Of the 32 surveys to date at this site, 50% of MCI scores have been less than 86 units while only 6% have been greater than 96 units.

#### 3.2.21.3.4 Temporal trends in 1995 to 2015data

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 = 32
Kendall tau = +0.192
p level = 0.122 [>FDR, p = 0.187]
N/S at p < 0.05

**Figure 99** LOWESS trend plot of MCI data at the site upstream of the coast

No statistically significant temporal trend has been found for the overall monitoring period despite a steady improvement in MCI scores over the initial seven year period followed by a smaller increase between 2008 and 2012. There has been a similar, although more pronounced, trend at the mid-catchment site at Wataroa Road. However, there has been an ecologically important range (of 13 units) 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 since 2000 there has been a narrower, ecologically insignificant, range of MCI scores (eight units). In more recent years, there has been an increase in water abstraction in the lower reaches for irrigation purposes.

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, after improving from 'worse than expected' prior to 2000.

### 3.2.21.4 Discussion

Seasonal MCI values decreased between spring and summer at all sites, from Wiremu Road (three units), to the Wataroa Road site (10 units), to the site near the coast (three units), but less typical of past summer larger decreases in MCI scores at two of the sites. This seasonal variability may be compared with median historical seasonal decreases of nine, three, and eight units for these three sites in a downstream direction (Appendix II). Seasonal communities shared 58% of the 31 taxa found at the upper mid-reach (Wiremu Road) site, 67% of 24 taxa at Wataroa Road, and 65% of 26 taxa at the furthest downstream site in the lower reaches near the coast, indicative of dissimilarity in seasonal community compositions and atypically more so at the upper mid-reach site.

Community composition varied markedly through the upper mid-reach to lower reach length of the stream surveyed. A total of 35 taxa was recorded in spring of which only 14 taxa (40%) 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*)] abundant at all three sites. A lower total of 32 taxa was found along the river's length by the summer survey (Table 167) of which 11 taxa (34%) were present at all three sites. Most of these were also widespread taxa in spring with a loss of four 'moderately sensitive' taxa and addition of one 'tolerant' taxon in summer. Only one 'moderately sensitive' and two 'tolerant' taxa were abundant at all three sites in summer. These dissimilarities in spatial community structure along the surveyed length (upper mid-reaches to lower reaches) of the Kapoaiaia Stream typically showed more of a difference in summer.

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 33 units in spring and atypically, to a similar extent by 34 units in summer, over a river distance of 19.5 km. These seasonal falls in MCI scores equated to average rates of decline of 1.7 units/km (spring) and 1.75 units/km (summer), much greater than the predicted average 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 average rates, this was less typical of the trend of past summer increases in average rates of decline.

Between the upper mid-reach site (Wiremu Road) and Wataroa Road mid-reach site, both the spring (3.3 units/km) and particularly the summer (4.2 units/km) average rates of decline were higher than the predicted average 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 (0.6 unit/km) and summer (0.1 unit/km) average rates of decline were equivalent with or lower than the predicted average rate of 0.6 unit/km.

Using the long-term median SEM MCI scores for each site (Appendix II), the average 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 2.3 units and 0.8 unit per km respectively with an overall median average rate of decline of 1.4 MCI units/km over the surveyed length of the stream. Therefore average rates of MCI decline over the 2014-2015 period tended to be higher than the average historical (1995 to 2014) median rates with the exception of the seasonal average rates over the mid-lower reach of the stream, particularly in summer 2015.

## 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 (2014) and summer (2014-2015) 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-nine surveys have been undertaken, between 1995 and February 2014, at this mid-reach, 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, together with spring 2014 and summer 2015 results

| Site code | SEM data ( 1995 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KRP000300 | 39 | 13-32 | 22 | 80-103 | 94 | 20 | 102 | 17 | 104 |

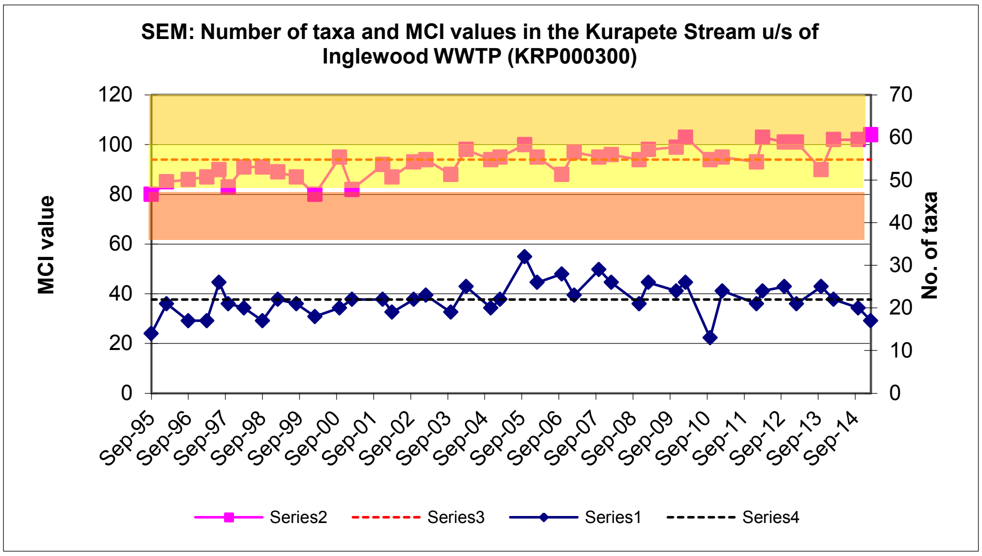



**Figure 100** Numbers of taxa and MCI values in the Kurapete Stream upstream of the Inglewood WWTP

A relatively wide range of richnesses (13 to 32 taxa) has been found with a moderate median richness of 22 taxa, relatively typical of richnesses in the mid reaches of ringplain streams rising outside the National Park boundary. During the 2014-2015 period spring (20 taxa) and summer (17 taxa) richnesses were relatively similar with the spring and summer richnesses lower by two to five taxa than this median richness coincident with patchy (spring) and thin (summer) periphyton layers on the predominantly stony-bouldery substrate of this shaded site.

MCI values have had a moderate range (23 units) at this site, typical of mid-reach sites in seepage streams 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 (TRC, 2015a). The spring, 2014 (102 units) and summer, 2015 (104 units) scores were very similar and from eight to 10 units higher than the historical median score. The summer score was one unit above the historical maximum score (found in summer 2012) for this site. The scores categorised this site as having 'good' (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 seepage 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.

### 3.2.22.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [39 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| PLATYHELMINTHES | *Cura* | 3 | 1 | 3 | | |
| NEMERTEA | Nemertea | 3 | 1 | 3 | | |
| ANNELIDA | Oligochaeta | 1 | 30 | 77 | A | A |
| MOLLUSCA | *Potamopyrgus* | 4 | 25 | 64 | A | VA |
| CRUSTACEA | Paraleptamphopidae | 5 | 3 | 8 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 12 | 31 | | A |
| | *Coloburiscus* | 7 | 0 | 0 | | A |
| | *Deleatidium* | 8 | 4 | 10 | | |
| | *Zephlebia group* | 7 | 18 | 46 | VA | VA |
| PLECOPTERA | *Acroperla* | 5 | 2 | 5 | | |
| COLEOPTERA | Elmidae | 6 | 21 | 54 | | VA |
| MEGALOPTERA | *Archichauliodes* | 7 | 13 | 33 | A | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 27 | 69 | | A |
| | *Hydrobiosis* | 5 | 3 | 8 | | |
| DIPTERA | *Aphrophila* | 5 | 22 | 56 | | |
| | *Maoridiamesa* | 3 | 3 | 8 | | |
| | Orthocladiinae | 2 | 26 | 67 | | |
| | Tanypodinae | 5 | 1 | 3 | | |
| | *Austrosimulium* | 3 | 25 | 64 | | |

Prior to the current 2014-2015 period 18 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', nine 'moderately sensitive', and eight 'tolerant' taxa i.e. a relatively even balance between 'sensitive' and 'tolerant' taxa as might be expected in the mid-reaches of a ringplain stream rising outside the National Park.

Predominant taxa have included two 'moderately sensitive' taxa [elmid beetles and cranefly (*Aphrophila*)] and five 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), orthoclad midges, and sandfly (*Austrosimulium*)].

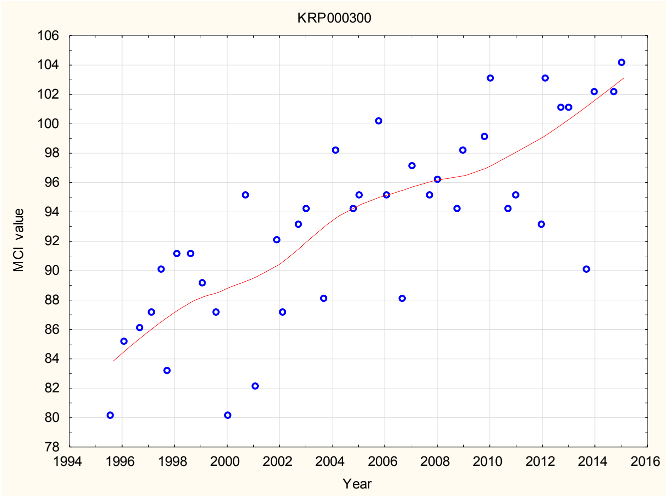
Four of the historically characteristic taxa were dominant in the spring, 2014 community (Table 105) and were comprised of two 'moderately sensitive' and two 'tolerant' taxa. Two of these taxa were also predominant historical taxa. The summer, 2015 community was characterised by all of the spring dominant taxa, plus one 'tolerant' taxon and three 'moderately sensitive' taxa, one of which [mayfly (*Coloburiscus*)] had not been characteristic of this site's community previously. Despite a seasonal summer increase in abundances of three 'moderately sensitive' taxa, an increase in abundances within two 'tolerant' taxa resulted in minimal change in $SQMCI_S$ score of 0.2 unit between seasons (Tables 168 and 169). All taxa which were recorded as very abundant during spring and/or summer had characterised this site's communities on 46% to 64% 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 (94 units) is nine units lower than this altitude prediction while the spring score (102 units) was one unit lower and the summer score (104 units) one unit higher than the predictive value. Of the 41 surveys to date at this site, virtually all (93%) of MCI scores have been less than 103 units, indicating that the recent spring and summer MCI scores were amongst the highest scores to date.

#### 3.2.22.1.4 Temporal trends in 1995 to 2015data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty 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 = 41
Kendall tau = +0.613
p level < 0.0001 [>FDR, p = < 0.0001]
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 strong earlier trend tended to ease between 2004 and 2009 with a subsequent increase in improvement more recently. The overall range of LOWESS-smoothed MCI scores (19 units) has been ecologically important.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) throughout the period bordering on 'good' very recently. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a ringplain stream, health has remained in the 'expected' category over the period subsequent to being in the 'worse than expected' category prior to 2002 (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-nine surveys have been undertaken at this lower reach site in the Kurapete Stream 6 km downstream of the Inglewood WWTP outfall (KRP000660) between 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data (1996 to February 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| KRP000660 | 39 | 14-30 | 25 | 70-112 | 93 | 28 | 105 | 26 | 93 |

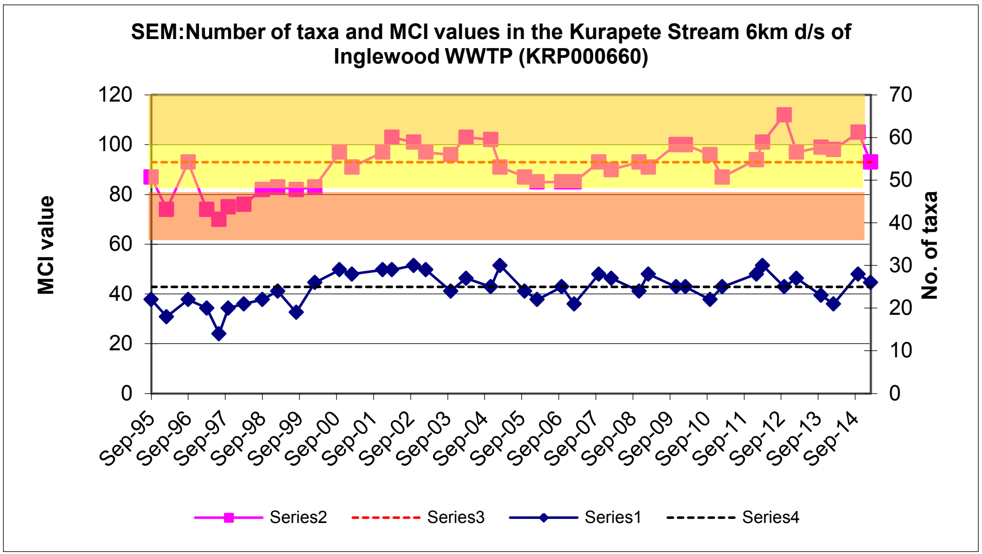



**Figure 102** Numbers of taxa and MCI values in the Kurapete Stream, 6 km downstream of the Inglewood WWTP outfall

A moderate range of richnesses (14 to 30 taxa) has been found, with a median richness of 25 taxa (slightly higher than typical of richnesses for the lower mid-reaches of ringplain streams rising outside the National Park boundary. During the 2014-2015 period spring (28 taxa) and summer (26 taxa) richnesses were similar and up to three taxa higher than this median richness.

MCI values have had a wide range (42 units) at this site. The median value (93 units) has been typical of lower mid-reach sites in similar seepage-fed streams elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (105 units) and summer, 2015 (93 units) scores were significantly different, higher than typical scores for such a site in spring, and equal with to 12 units higher than the historical median score. These scores categorised this site as having 'good' (spring) and 'fair'(summer) health generically (Table 1) but, in terms of predictive relationships (Table 2), 'expected' (spring and summer) health for the lower mid-reaches of a seepage-fed ringplain stream coincident with improved physicochemical water quality following the diversion of Inglewood WWTP discharges out of the catchment. The historical median score (93 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

### 3.2.22.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [39 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **PLATYHELMINTHES** | *Cura* | 3 | 1 | 3 | | |
| **NEMERTEA** | Nemertea | 3 | 3 | 8 | | |
| **NEMATODA** | Nematoda | 3 | 1 | 3 | | |
| **ANNELIDA** | Oligochaeta | 1 | 34 | 87 | VA | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 23 | 59 | | A |
| **CRUSTACEA** | Ostracoda | 1 | 1 | 3 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 7 | 18 | VA | A |
| | *Coloburiscus* | 7 | 8 | 21 | VA | A |
| | *Deleatidium* | 8 | 8 | 21 | VA | |
| | *Zephlebia group* | 7 | 9 | 23 | VA | VA |
| **PLECOPTERA** | *Zelandobius* | 5 | 8 | 21 | A | |
| **COLEOPTERA** | Elmidae | 6 | 24 | 62 | VA | VA |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 14 | 36 | A | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 25 | 64 | VA | XA |
| | *Costachorema* | 7 | 2 | 5 | | |
| | *Hydrobiosis* | 5 | 17 | 44 | A | A |
| | *Oxyethira* | 2 | 13 | 33 | | |
| | *Pycnocentrodes* | 5 | 8 | 21 | VA | |
| **DIPTERA** | *Aphrophila* | 5 | 28 | 72 | | A |
| | *Maoridiamesa* | 3 | 10 | 26 | A | |
| | Orthocladiinae | 2 | 38 | 97 | A | A |
| | Tanytarsini | 3 | 4 | 10 | | |
| | Empididae | 3 | 2 | 5 | | |
| | Muscidae | 3 | 3 | 8 | | |
| | *Austrosimulium* | 3 | 18 | 46 | | |

Prior to the current 2014-2015 period, 25 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and fourteen 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa, which is typical of the lower mid-reaches of a ringplain stream.

Predominant taxa have included two 'moderately sensitive' taxa [elmid beetles and cranefly (*Aphrophila*)] and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges].

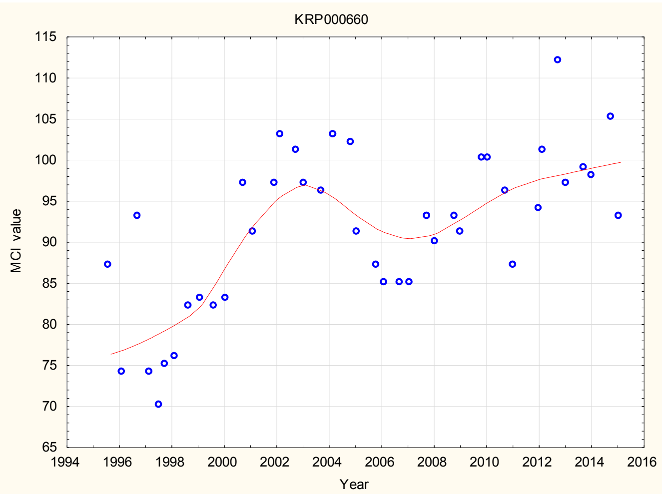
A relatively high number (13) of taxa were dominant in the spring, 2014 community comprising four of the predominant taxa (above) together with one 'highly sensitive', seven 'moderately sensitive', and one 'tolerant' historically characteristic taxa. The summer, 2015 community was characterised by eight of the taxa dominant in spring (but not the one 'highly sensitive' mayfly taxon), together with one additional 'moderately sensitive' taxon and one 'tolerant' taxon and two fewer 'moderately sensitive' and two 'tolerant' taxa, all of which previously had been characteristic of this site's communities (Table 107). In particular, reduced numerical abundance within one 'highly sensitive' taxon and increased numerical abundance in one 'tolerant' taxon in summer resulted in the difference in seasonal $SQMCI_s$ scores which decreased by 0.7 unit in summer (Tables 168 and 169). The five taxa which were recorded as very or extremely abundant in spring and/or summer had characterised this site's communities on 18% to 87% 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 (93 units) is 4 units lower than the altitude prediction and the spring survey score (105 units) was an insignificant eight units above the predictive value while the summer score (93 units) was four units below the predictive value. Of the 41 surveys to date at this site, 63% of MCI scores have been less than 97 units, indicating that the current spring and summer MCI scores were less 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 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the twenty years of SEM results collected to date from the site in the Kurapete Stream 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 = 41
Kendall tau = +0.429
p level <0.0001 [>FDR, $p < 0.001$]
Significant at $p < 0.05$ and $p < 0.01$, 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 important increase in LOWESS-smoothed score of 17 units over a five year period. Subsequently, a decreasing trend in scores has been followed by a steady recovery (since 2007) while the overall twenty-year trend has been statistically very significant after FDR application coincident with relatively few consented municipal wastes short-duration 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 the 2012 to 2015 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' prior to 2000 to the 'expected' category over the remainder of the period indicative of the positive effects of diversion of the WWTP discharge out of the stream.

#### 3.2.22.3 Discussion

Seasonal MCI values atypically increased (although only by two units) between spring and summer at the site upstream of the Inglewood WWTP outfall but typically decreased at the site 6km downstream (by a significant 12 units). These seasonal differences may be compared with historical seasonal medians (Appendix II) which indicate a summer increase of one unit at the upstream site and a summer decrease of three units at the lower site. Seasonal communities shared only 48% of the total of 25 taxa found at the mid-reach site, but 59% of the total of 34 taxa found at the downstream lower mid-reach site indicative of marked seasonal community dissimilarities which were more pronounced at the upstream mid-reach site.

MCI score increased atypically by three units in spring and decreased by a significant 11 units in summer in a downstream direction between the two sites coincident with the diversion of wastewater discharges from the Inglewood WWTP out of the stream and no consented overflow discharges prior to either survey during the 2014-2015 period. The summer result was less typical of minimal downstream deterioration recorded by most surveys since 2000. These average rates of decline in MCI (0 to 1.7 MCI units/km) ranged from below to well above the average rate expected through the mid reaches of Taranaki ringplain rivers and streams sourced outside of the National Park (TRC, 2015a).

Using the long-term median SEM MCI scores for each site (Appendix II), the average rate of decline between these mid-reach and lower mid-reach sites has been only 0.2 MCI unit/km over the surveyed length. Therefore average rates of MCI decline over the 2014-2015 period were lower in spring but much higher in summer than the median historical average rate for the 1995 to 2014 period.

Community composition varied markedly through the mid-reach to lower mid-reach length of the stream surveyed. A total of 31 taxa was recorded in spring of which 17 taxa (55%) were present at both sites. These included two 'highly sensitive', eight 'moderately sensitive', and seven 'tolerant' taxa with only two 'moderately sensitive' and one 'tolerant' taxa abundant at both sites. The same total of 31 taxa was found along the stream's surveyed length by the summer survey of which only eleven taxa (35%) were present at both sites. They were relatively similar to the widespread taxa in spring with two fewer 'highly sensitive', two fewer 'moderately sensitive', and one fewer 'tolerant' taxa. Seven taxa were abundant at both sites in summer; two 'tolerant' and five 'moderately sensitive' taxa. Dissimilarities in spatial community structure along the surveyed length of the Kurapete Stream were more typical of most seasonal structures to date which have shown greater summer dissimilarity.

## 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-practice dairy-farming initiatives being evaluated in five dairying catchments throughout the country (Wilcock et al, 2009). Fonterra, Kapuni lactose factory also irrigates wastewater to land in the mid reaches of this catchment. One site is located upstream of the irrigation area (in mid-catchment) and the other site approximately 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 temporal trend purposes in the 2008-2009 period to provide an additional monitoring component of the collaborative study.

The results of spring (2014) and summer (2014-2015) surveys are summarised in Tables 170 and 171, Appendix I.

### 3.2.23.1 Skeet Road site (WKR000500)

#### 3.2.23.1.1 Taxa richness and MCI

Seventeen surveys have been undertaken, between 2003 and February 2014, at this mid-reach, partially shaded site, draining open developed farmland upstream of the Fonterra, Kapuni wastewater irrigation area. These results are summarised in Table 108, together with the results from 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 2014 and summer 2015 results

| Site code | SEM data (2003 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WKR000500 | 19 | 18-29 | 23 | 88-114 | 99 | 21 | 102 | 19 | 106 |

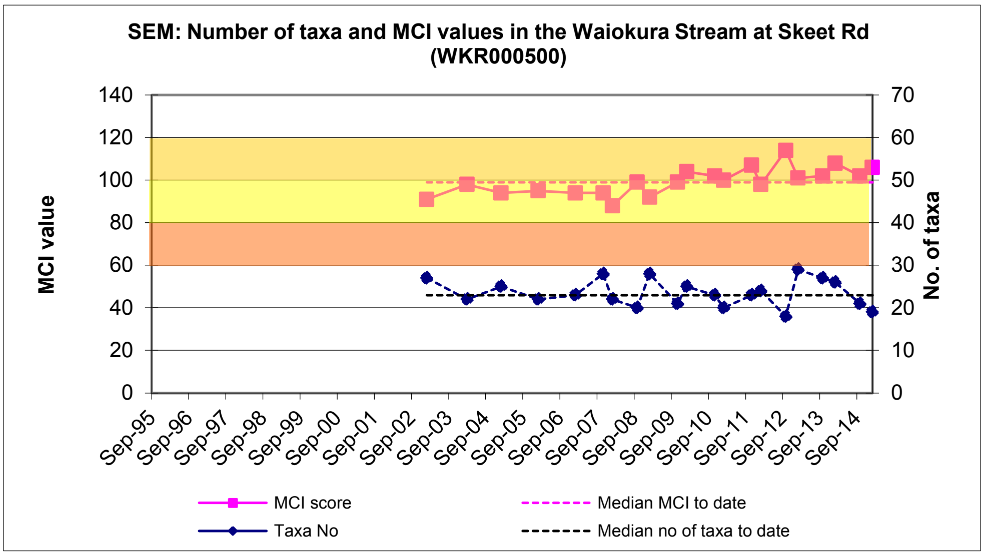



**Figure 104** Numbers of taxa and MCI values in the Waiokura Stream at Skeet Road

A relatively narrow range of richnesses (18 to 29 taxa) has been found to date with a median richness of 23 taxa more typical of richnesses in the mid reaches of ringplain streams rising outside the National park boundary. During the 2014-2015 period spring (21 taxa) and summer (19 taxa) richnesses were similar but two to four taxa less than this median richness coincident with minimal periphyton on the predominantly gravel-cobble substrate of this site in spring and in summer despite following relatively lengthy flow recession periods on both occasions, particularly in summer.

MCI values have had a moderate range (26 units) at this site, more typical of mid reach sites on the ringplain, although the monitoring period has been relatively short to date. The historical median value (99 units) has been typical of mid-reach sites in streams rising outside the National Park elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (102 units) and summer, 2015 (106 units) scores were three units and seven units above the historical median respectively. The summer score was atypically four units higher than the spring score at this site. The scores categorised this site as having 'good' (spring and summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'expected' health for the mid-reaches of a ringplain stream on these occasions. The historical median score (99 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

### 3.2.23.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 period are listed in Table 109.

**Table 109** Characteristic taxa (abundant, very abundant, extremely abundant) recorded in the Waiokura Stream at Skeet Road, between 2003 and February 2014 [19 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| NEMERTEA | Nemertea | 3 | 1 | 5 | | |
| ANNELIDA | Oligochaeta | 1 | 9 | 47 | A | |
| MOLLUSCA | *Potamopyrgus* | 4 | 6 | 32 | A | |
| CRUSTACEA | *Paracalliope* | 5 | 1 | 5 | | |
| | Paraleptamphopidae | 5 | 1 | 5 | | |
| EPHEMEROPTERA | *Austroclima* | 7 | 19 | 100 | VA | VA |
| | *Coloburiscus* | 7 | 6 | 32 | | A |
| | *Deleatidium* | 8 | 12 | 63 | | |
| | *Zephlebia group* | 7 | 7 | 37 | A | VA |
| PLECOPTERA | *Zelandobius* | 5 | 2 | 11 | A | |
| COLEOPTERA | Elmidae | 6 | 19 | 100 | VA | A |
| MEGALOPTERA | *Archichauliodes* | 7 | 12 | 63 | | A |
| TRICHOPTERA | *Hydropsyche (Aoteapsyche)* | 4 | 19 | 100 | A | VA |
| | *Costachorema* | 7 | 1 | 5 | | |
| | *Hydrobiosis* | 5 | 4 | 21 | | |
| | *Confluens* | 5 | 1 | 5 | | |
| | *Pycnocentrodes* | 5 | 9 | 47 | | |
| DIPTERA | *Aphrophila* | 5 | 1 | 5 | | |
| | *Maoridiamesa* | 3 | 3 | 16 | | |
| | Orthocladiinae | 2 | 7 | 37 | | |
| | Tanytarsini | 3 | 1 | 5 | | |
| | *Austrosimulium* | 3 | 2 | 11 | | |

Prior to the current 2014-2015 period 22 taxa had characterised the community at this site on occasions. These have comprised only one 'highly sensitive', 13 'moderately sensitive' and eight 'tolerant' taxa i.e. a moderately high proportion (64%) of 'sensitive' taxa as would be expected in the mid-reaches of a ringplain stream rising outside the National Park.

Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; three 'moderately sensitive' taxa [mayfly (*Austroclima*), elmid beetles, and dobsonfly (*Archichauliodes*)]; and two 'tolerant' taxa [oligochaete worms and net-building caddisfly (*Hydropsyche-Aoteapsyche*]. Two of the 'moderately sensitive' and one of the 'tolerant' taxa have been dominant on all survey occasions (Table 109).

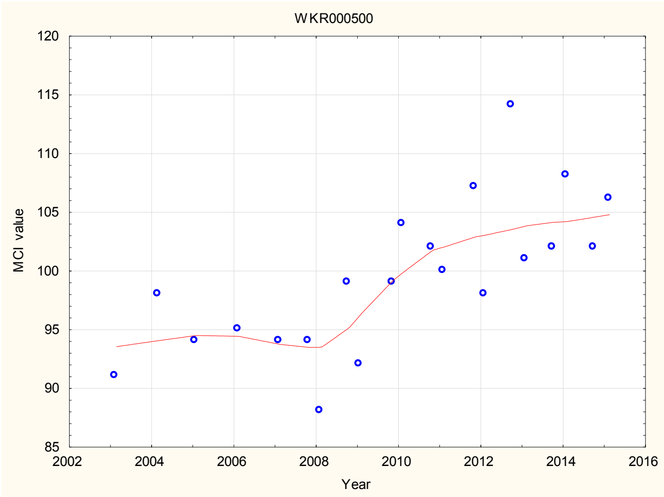
Seven of the historically characteristic taxa were dominant in the spring, 2014 community comprising three of the predominant taxa (above) together with two other 'moderately sensitive' taxa and two other 'tolerant' taxa. The summer, 2015 community was characterised by one fewer taxon; four of the taxa dominant in spring, with two fewer 'tolerant' taxa and one additional 'moderately sensitive' taxon. However, few changes in overall abundances within both 'sensitive' and 'tolerant 'dominant taxa resulted in a minimal change in the seasonal $SQMCI_s$ scores of 0.2 unit (Tables 170 and 171). The four taxa which were recorded as very/extremely abundant during spring and/or summer had characterised this site's communities on 37% 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 (99 units) is one unit below this altitude prediction while the spring survey score (102 units) and the summer score (106 units) were equal with (spring) an insignificant six units higher (summer) than the predictive value. Of the 19 surveys to date at this site, 47% of MCI scores have been less than 100 units, indicating that the current spring and summer MCI scores were relatively typical 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 2002 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed as the duration and frequency (in particular) of data collection has been insufficient to date for 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.




N = 21
Kendall tau = +0.572

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

More recently (since 2009) there has been relatively strong temporal improvement in MCI scores at this site. The LOWESS-smoothed range of MCI scores (12 units) has bordered on ecological importance and increases in scores may have been related to improvements in farming practices and/or wastes disposal in the rural catchment between the stream's seepage sources (below the National Park) and mid reaches at Skeet Road, although the shorter duration and less frequent initial monitoring must be noted.

LOWESS-smoothed MCI scores have been indicative of 'fair' generic stream health (Table 1) for the first seven years of the period improving to the 'good' health category over the most recent five years. In terms of predictive relationships (Table 2) for a site in the mid-reaches of a seepage-fed ringplain stream, health has remained in the 'expected' category over the entire twelve year period (Figure 105).

### 3.2.23.2 Manaia golf course site (WKR000700)

#### 3.2.23.2.1 Taxa richness and MCI

Fourteen surveys have been undertaken at this more recently established lower reach site in the Waiokura Stream at Manaia between 2007 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data (2007 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| WKR000700 | 14 | 16-27 | 23 | 92-105 | 99 | 16 | 109 | 19 | 98 |

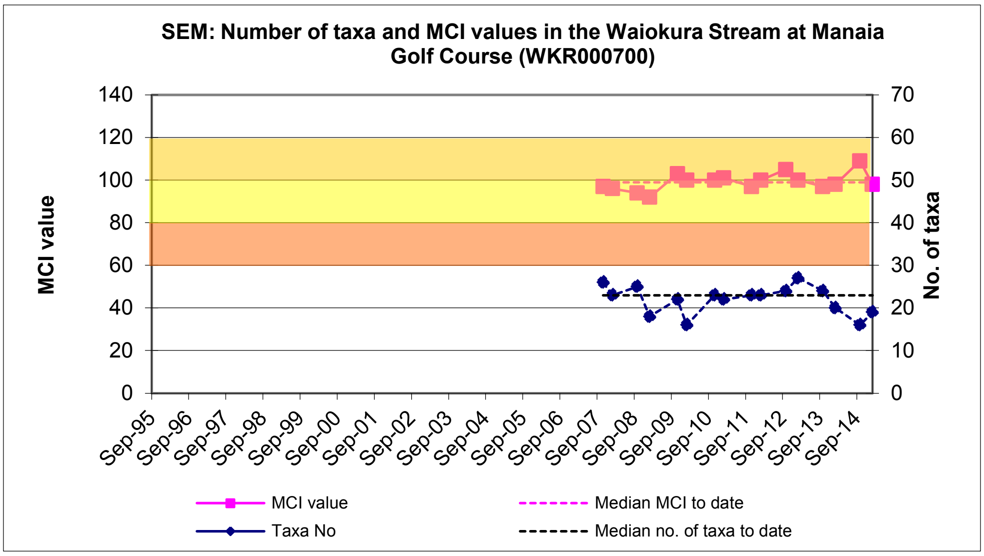



**Figure 106** Numbers of taxa and MCI values in the Waiokura Stream at Manaia Golf course

A moderate range of richnesses (16 to 27 taxa) has been found, with a median richness of 23 taxa (more representative of typical richnesses for the lower reaches of ringplain streams rising outside the National Park boundary). During the 2014-2015 period spring (16 taxa) and summer (19 taxa) richnesses were relatively similar but up to seven taxa fewer than this median richness. The spring 2014 richness was equivalent with the previous minimum taxa number recorded.

MCI values have had a narrow range (13 units) at this site partly due to the short duration of the monitoring period to date. The median value (99 units) has been slightly higher than typical of similar lower reach sites elsewhere on the ringplain (TRC, 2015a). The spring, 2014 (109 units) and summer, 2015 (98 units) scores were typically dissimilar with the latter one unit below the historical median. The spring score was 10 units above the historical median and four units higher than scores previously recorded at this site. These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 1) and, in terms of predictive relationships (Table 2), 'better than expected' (spring) and 'expected' (summer), health for the lower reaches of a ringplain stream coincident with some riparian cover within the golf course reaches. The historical median score (99 units) placed this site in the 'fair' and 'expected' categories for generic and predictive methods of assessment respectively.

#### 3.2.23.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site for the relatively short monitoring period prior to the 2014-2015 surveys 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 2014 [14 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMATODA** | Nematoda | 3 | 1 | 7 | | |
| **ANNELIDA** | Oligochaeta | 1 | 12 | 86 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 6 | 43 | | |
| **CRUSTACEA** | *Paracalliope* | 5 | 1 | 7 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 14 | 100 | VA | VA |
| | *Coloburiscus* | 7 | 9 | 64 | A | A |
| | *Deleatidium* | 8 | 1 | 7 | | |
| | *Zephlebia group* | 7 | 14 | 100 | VA | VA |
| **PLECOPTERA** | *Zelandobius* | 5 | 2 | 14 | | |
| **COLEOPTERA** | Elmidae | 6 | 14 | 100 | A | VA |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 12 | 86 | | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 11 | 79 | A | VA |
| | *Hydrobiosis* | 5 | 1 | 7 | | |
| | *Pycnocentria* | 7 | 1 | 7 | | |
| | *Pycnocentrodes* | 5 | 3 | 21 | | |

Prior to the current 2014-2015 period, 15 taxa had characterised the community at this site on occasions. These have comprised one 'highly sensitive', ten 'moderately sensitive', and four 'tolerant' taxa i.e. a higher proportion of 'sensitive' taxa than might be expected in the lower reaches of a ringplain stream, but coincident with the riparian cover provided within the Manaia golf course reach.

Predominant taxa have included five 'moderately sensitive' taxa [mayflies (*Austroclima*, *Zephlebia* group, and *Coloburiscus*), elmid beetles and dobsonfly (*Archichauliodes*)] and two 'tolerant' taxa [oligochaete worms and net-building caddisfly (*Hydropsyche-Aoteapsyche*)].

Five of these historically characteristic taxa were dominant in the spring, 2014 community comprising five of the predominant taxa (above). The summer, 2015 community was characterised by all of the taxa dominant in spring, plus one additional 'moderately sensitive' taxon (Table 111). Increased summer abundances within one 'tolerant' taxon in particular resulted in a small decrease of 0.5 unit in seasonal $SQMCI_s$ scores which were relatively high (6.0 to 6.5 units) for the lower reaches of a ringplain seepage stream (TRC, 2015a) (Tables 170 and 171). The four taxa which were recorded as very abundant during spring and/or summer had characterised this site's communities on 79% 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 relatively short-term historical site median (99 units) is seven units above this altitude prediction coincident with patchy riparian vegetation cover in the reaches through the Manaia golf course. The spring survey score (109 units) was significantly (Stark, 1998) 17 units above the predictive value and the summer score (98 units) was insignificantly higher than this predictive value by six units. Of the sixteen surveys to date at this site, no MCI scores have been less than the predicted 92 units. The spring score was better than typical historical conditions while the summer MCI score was more typical of historical conditions, although the monitoring period has been relatively short (eight years) to date.

#### 3.2.23.2.4 Temporal trends in 2007 to 2015 data

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the eight years of SEM results collected to date from the site in the Waiokura Stream at Manaia golf course due to the relatively 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.

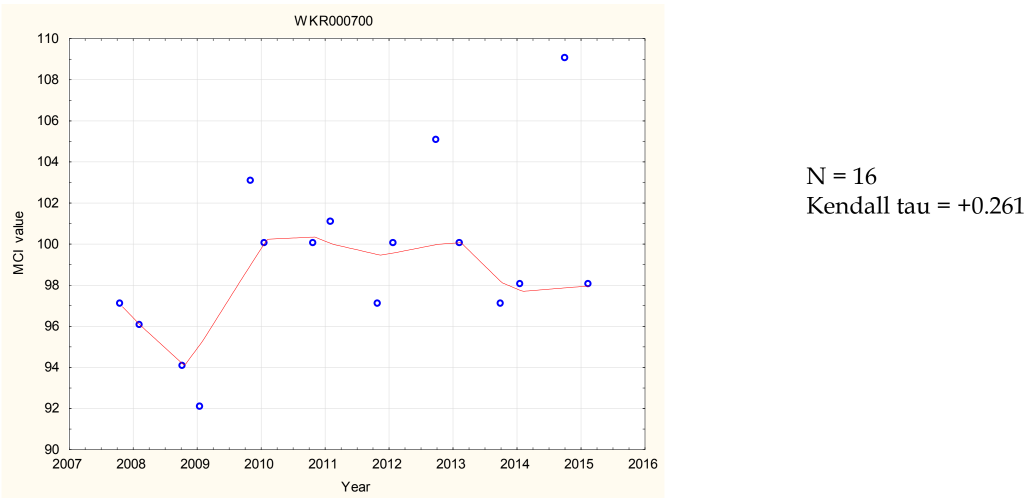



**Figure 107** LOWESS trend plot of MCI data for the Manaia golf course

A similar temporal trend of improvement in MCI scores since 2009 to that found at the upstream site (at Skeet Road) was identified at this site at the Manaia golf course (although more stable since 2010) but the short duration of the data record must be noted at this stage. The relatively narrow LOWESS-smoothed range of scores (six units) has no ecological importance to date.

The smoothed MCI scores which indicated 'fair' generic stream health (Table 1) for two years of the monitoring period, improved to 'good' stream health for about three years before returning to 'fair' stream health most recently. 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 over the period (although approaching the 'better than expected' category on occasions), 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 atypically increased (by four units) at the mid-reach site but less typically decreased (by nine units) between spring and summer at the site in the lower reaches. These seasonal differences may be compared with the historical median seasonal summer decrease of four units at the Skeet Road site and no change between seasons at the Manaia Golf Course site (Appendix II). Seasonal communities shared only 43% (12 of the 28 taxa) found at the mid-reach site and 61% (13 of 22 taxa) at the downstream site in the lower reaches at Manaia indicative of greater similarity in seasonal community composition in a downstream direction at the site within the riparian covered reaches, which has typically been the case in this stream.

MCI score increased by seven units in spring and decreased by eight units in summer in a downstream direction over the 9.7 km reach, between the more open farmland mid-reach site (Skeet Road) and the lower reach Manaia golf course site, despite some improvement in habitat provided by patches of riparian vegetation cover through the golf course. A marked increase in periphyton substrate cover was noted at the downstream site under prolonged low recession flow conditions in late summer. These differences in MCI scores between sites represented an averge rate of MCI decrease of nil units/km (spring) but 0.8 unit/km (summer); lower than the average rate expected through the mid to lower reaches of Taranaki ringplain rivers and streams sourced outside of the National Park (TRC, 2015a).

Using the longer-term median SEM MCI scores for each site (for the relatively short period 2007 to date), there has been a very small improvement between the mid-reach site at Skeet Road and the lower reach site near Manaia over the surveyed length. Therefore average rate of MCI change in the 2014-2015 period was atypically better in spring and worse in summer in terms of the median average historical rate of change.

Community composition varied through the mid reach to lower reach length of the stream surveyed. A total of 25 taxa was recorded in spring of which only 12 taxa (48%) were present at both sites. These included no 'highly sensitive', nine 'moderately sensitive', and three 'tolerant' taxa with only three 'moderately sensitive' and one 'tolerant' taxa abundant at both sites. The same total (25 taxa) was found along the stream's surveyed length by the summer survey of which 13 taxa (52%) were present at both sites. They were generally similar to the widespread taxa in spring with a small decrease in the number of 'sensitive' taxa and a small increase in the number of 'tolerant' taxa. Additional two 'moderately sensitive' taxa were abundant at both sites in summer. Dissimilarities in spatial community structure along the surveyed length (mid to lower reaches) of the Waiokura Stream atypically were slightly less pronounced in summer than in spring.

## 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 (afforestation) particularly in the upper-mid catchment. The Fonterra, Hawera dairy factory abstracts water from the river in the lower catchment for processing purposes. Two of the three sites are in the upper to mid, shallow gradient, reaches of the river (the upstream site within 4 km of the headwaters) with the third site in the lower reaches, some 4 km from the coast.

The results of the spring, 2014 survey are presented in Table 172 and the summer, 2014–2015 survey in Table 173, Appendix I.

### 3.2.24.1 Upper Tangahoe Valley Road site (TNH000090)

#### 3.2.24.1.1 Taxa richness and MCI

Fourteen surveys have been undertaken at this upper reach site in the Tangahoe River between December 2007 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data (2007 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Nov 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| TNH000090 | 14 | 17-31 | 24 | 90-107 | 98 | 27 | 95 | 26 | 105 |

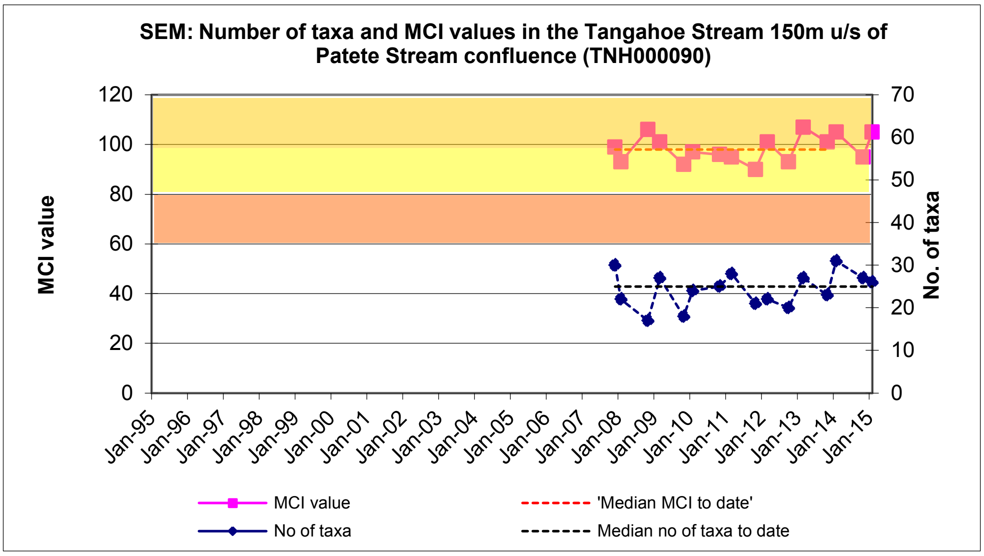



**Figure 108** Numbers of taxa and MCI values in the Tangahoe River at Upper Tangahoe Valley Road

A relatively wide range of richnesses (17 to 31 taxa) has been found with a moderate median richness of 24 taxa (lower than richnesses which might be anticipated toward the upper reaches of hill country rivers) but higher than the median richness (20 taxa) for sites at this relatively low altitude (85 m asl) (TRC, 2015a). During the 2014-2015 period, spring (27 taxa) and summer (26 taxa) richnesses were very similar and two to three taxa more than this median richness.

MCI values have had a relatively narrow range (17 units) at this site, more typical of scores at sites toward the upper reaches of streams and rivers. However, the median value (98 units) has been more typical of mid reach sites elsewhere and five units above the median score recorded by 55 previous surveys at 'control' sites located at similar altitudes (to the upper Tangahoe Valley Road site) in hill country rivers and streams (TRC, 2015a). The spring, 2014 (95 units) and summer, 2015 (105 units) scores were dissimilar and three units lower to seven units higher than the historical median. These scores categorised this site as having 'fair' health (spring) and 'good' health (summer) generically (Table 1). The historical median score (98 units) placed 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 2014-2015 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 2014 [14 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **ANNELIDA** | Oligochaeta | 1 | 8 | 57 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 12 | 86 | A | VA |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 14 | 100 | A | VA |
| | *Deleatidium* | 8 | 12 | 86 | VA | VA |
| | *Zephlebia group* | 7 | 6 | 43 | VA | A |
| **PLECOPTERA** | *Megaleptoperla* | 9 | 3 | 21 | | |
| **COLEOPTERA** | Elmidae | 6 | 13 | 93 | A | VA |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 3 | 21 | | |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 2 | 14 | | A |
| | *Hydrobiosis* | 5 | 3 | 21 | | |
| **DIPTERA** | Orthocladiinae | 2 | 3 | 21 | | |
| | *Austrosimulium* | 3 | 11 | 79 | A | |

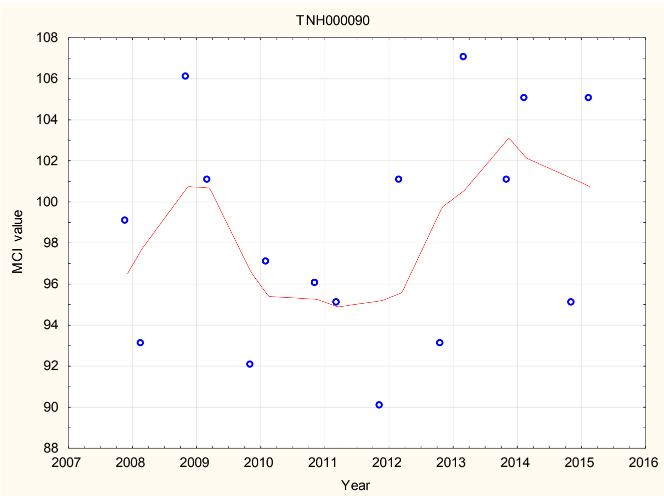
Prior to the current 2014-2015 period, 12 taxa have characterised the community at this site on occasions. These have comprised two 'highly sensitive', five 'moderately sensitive', and five 'tolerant' taxa i.e. a higher proportion of 'tolerant' taxa than would be expected toward the upper reaches of hill-country river, reflecting the relatively flat gradient of this river to this site. Predominant taxa have included one 'highly sensitive' taxon (mayfly (*Deleatidium*)); two 'moderately sensitive' taxa [mayfly (*Austroclima*) and elmid beetles]; and three 'tolerant' taxa [snail (*Potamopyrgus*), oligochaete worms, and sandfly (*Austrosimulium*)]. Five of these predominant taxa were dominant in the spring, 2014 community together with one additional 'moderately sensitive' taxon. The summer, 2015 community was characterised by five of the taxa dominant in spring, together with one additional taxon which previously had been characteristic of this site's communities and one fewer 'tolerant' taxon (Table 113). The few seasonal differences in characteristic taxa, and absence of any significant differences in numerical dominances within these taxa between spring and summer surveys were reflected in the similar seasonal $SQMCI_s$ scores which varied by only 0.4 unit (Table 172 and 173). The five taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 43% 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 toward the upper reaches of this low gradient river draining an eastern hill country catchment. The relationship for ringplain streams and river developed between MCI and altitude (Stark and Fowles, 2009) is therefore not appropriate for this river.

### 3.2.24.1.4 Temporal trends in 2007 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the eight years of SEM results collected to date from the site in the Tangahoe River at upper Tangahoe Valley Road due to the relatively short duration of the data record (i.e. less than ten years). 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.




N = 16
Kendall tau = +0.137

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

Some temporal trend of improvement in MCI scores may be interpreted for this hill country catchment site toward the upper reaches, but its significance cannot be fully evaluated due to the relatively short monitoring period to date. The range of smoothed MCI scores (eight units) has limited ecological importance to date but cannot be fully assessed until the monitoring period is of sufficient duration.

Smoothed MCI scores fluctuating between 'fair' over the majority of the period and 'good' generic river health since 2013 (Table 1) have been recorded over the eight year period (Figure 109).

### 3.2.24.2 Tangahoe Valley Road bridge site (TNH000200)

#### 3.2.24.2.1 Taxa richness and MCI

Fourteen surveys have been undertaken at this mid reach site in the Tangahoe River between December 2007 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data (2007 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Nov 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| TNH000200 | 14 | 20-33 | 25 | 92-108 | 104 | 25 | 99 | 35 | 109 |

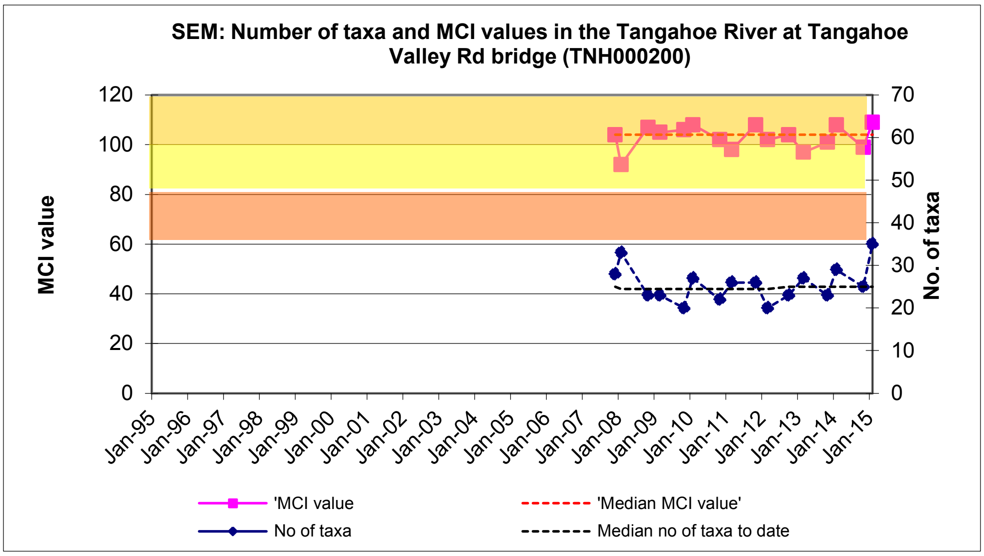



**Figure 110** Numbers of taxa and MCI values in the Tangahoe River at Tangahoe Valley Road bridge

A moderate range of richnesses (20 to 33 taxa) has been found with a relatively good median richness of 25 taxa (typical of richnesses in the mid-reaches of hill country rivers). During the 2014-2015 period, spring richness (25 taxa) was equivalent with the median, while summer richness (35 taxa) was well above this median taxa number and two taxa greater than the previous maximum.

MCI values have had a moderate range (16 units) at this site, typical of a site in the mid-reaches of hill country streams and rivers. The median value (104 units) has also been typical of mid-reach sites elsewhere and two units above the median score recorded by 20 previous surveys at ‘control’ sites located at similar altitudes in eastern hill country rivers and streams (TRC, 2015a). The spring, 2014 (99 units) and summer, 2015 (109 units) scores were an insignificant five units lower to five units higher than the historical median. These scores categorised this site as having ‘fair’ health generically (Table 1) in spring and ‘good’ health in summer. The historical median score (104 units) placed this site in the ‘good’ category for the generic assessment of health.

### 3.2.24.2.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 2014 [14 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **ANNELIDA** | Oligochaeta | 1 | 2 | 14 | | |
| **MOLLUSCA** | *Potamopyrgus* | 4 | 9 | 64 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 14 | 100 | VA | VA |
| | *Coloburiscus* | 7 | 5 | 36 | | A |
| | *Deleatidium* | 8 | 12 | 86 | VA | A |
| | *Rallidens* | 9 | 1 | 7 | | |
| | *Zephlebia group* | 7 | 9 | 64 | | A |
| **PLECOPTERA** | *Acroperla* | 5 | 2 | 14 | A | |
| | *Zelandobius* | 5 | 6 | 43 | A | |
| **COLEOPTERA** | Elmidae | 6 | 14 | 100 | VA | VA |
| **MEGALOPTERA** | *Archichauliodes* | 7 | 3 | 21 | | A |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 11 | 79 | A | VA |
| | *Hydrobiosis* | 5 | 5 | 36 | | A |
| | *Oxyethira* | 2 | 2 | 14 | | |
| | *Pycnocentrodes* | 5 | 1 | 7 | | |
| **DIPTERA** | *Aphrophila* | 5 | 8 | 57 | A | |
| | Orthocladiinae | 2 | 8 | 57 | | A |
| | Tanytarsini | 3 | 5 | 36 | | VA |
| | *Austrosimulium* | 3 | 4 | 29 | A | |

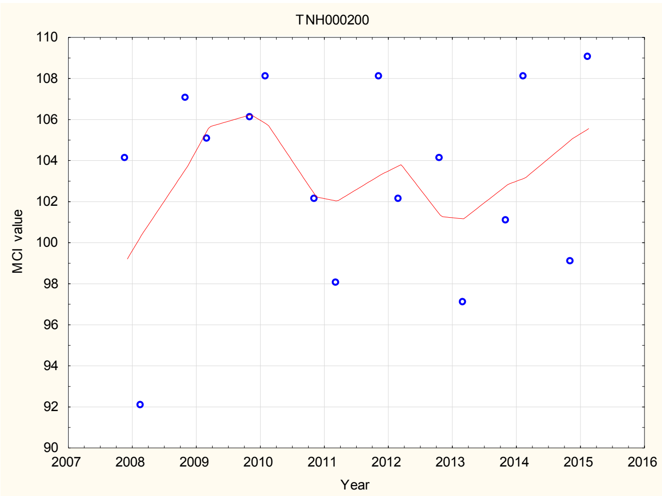
Prior to the current 2014-2015 period, 19 taxa have characterised the community at this site on occasions. These have comprised two 'highly sensitive', ten 'moderately sensitive', and seven 'tolerant' taxa i.e. a relatively high proportion of 'sensitive' taxa as would be expected in the mid-reaches of a hill-country river. Predominant taxa have included one 'highly sensitive' taxon [mayfly (*Deleatidium*)]; four 'moderately sensitive' taxa [mayflies (*Austroclima* and *Zephlebia* group), elmid beetles, and cranefly (*Aphrophila*)]; and three 'tolerant' taxa [snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges]. Five of these predominant taxa were dominant in the spring, 2014 community together with two other 'moderately sensitive' and one other 'tolerant' taxa which had been characteristic previously. The summer, 2015 community was characterised by four of the taxa dominant in spring, together with an additional four 'moderately sensitive' and two 'tolerant' taxa; all of which previously had been characteristic of this site's communities and loss of three 'moderately sensitive' and one 'tolerant' taxa (Table 115). An increase in summer numerical abundances within two 'tolerant' taxa and decreased abundance within the one 'highly sensitive' taxon principally were responsible for the decrease of 1.0 unit in seasonal $SQMCI_s$ scores (Tables 172 and 173). The four taxa recorded as very abundant during spring and/or summer had characterised this site's communities on 36% to 100% of the past survey occasions.

#### 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 a 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 2007 to 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the eight years of SEM results collected to date from the site in the Tangahoe River at the Tangahoe Valley Road bridge site due to the relatively short period of data record (i.e. less than ten years). 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.




N = 16
Kendall tau = + 0.043

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

An overall temporal trend of minimal increase in MCI scores may be interpreted for this mid river reach, hill country catchment site but no statistical significance can be assessed due to the relatively short monitoring period to date. The range of smoothed MCI scores (seven units) over the period has limited ecological importance, but cannot be fully assessed until the monitoring period is of sufficient duration.

Smoothed MCI scores have indicated 'good' generic river health (Table 1) over the entire eight year period.

### 3.2.24.3 Site downstream of railbridge (TNH000515)

#### 3.2.24.3.1 Taxa richness and MCI

Fifteen surveys have been undertaken at this lower reach site in the Tangahoe River between August 1997 and February 2014 with twelve 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 2014 and summer 2015 results

| Site code | SEM data ( 1997 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Nov 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| TNH000515 | 15 | 13-26 | 20 | 84-104 | 92 | 19 | 97 | 21 | 97 |

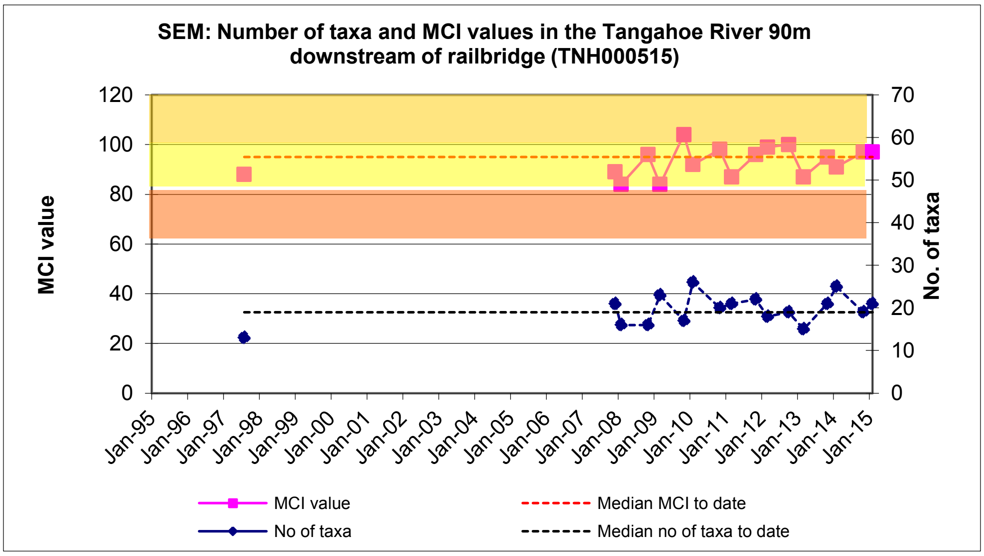



**Figure 112** Numbers of taxa and MCI values in the Tangahoe River downstream of the railbridge

A moderate range of richnesses (13 to 26 taxa) has been found with a slightly higher than typical median richness of 20 taxa for a site in the lower reaches of a hill country river (TRC, 2015a) During the 2014-2015 period, spring (19 taxa) and summer (21 taxa) richnesses were similar and within one taxon of this median richness.

MCI values also have had a moderate range (20 units) at this site, narrower than typical of sites in the lower reaches of hill country streams and rivers, but reference is made to the relatively short monitoring period at this site. The median value (92 units) has been more typical of lower reach sites elsewhere in the region but a significant 15 units higher than the median score (77 units) recorded by 226 previous surveys at 'control' sites located at similar altitudes (to this site) in hill country rivers and streams (TRC, 2015a). The spring, 2014 (97 units) and summer, 2015 (97 units) scores were identical and five units above the historical median. These scores categorised this site as having 'fair' health generically (Table 1) in both spring and in summer. The historical median score (92 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 2014-2015 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 2014 [15 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| **NEMERTEA** | Nemertea | 3 | 1 | 7 | | |
| **ANNELIDA** | Oligochaeta | 1 | 13 | 87 | A | |
| **MOLLUSCA** | *Latia* | 5 | 3 | 20 | | |
| | *Potamopyrgus* | 4 | 8 | 53 | | A |
| **CRUSTACEA** | *Paracalliope* | 5 | 1 | 7 | | |
| **EPHEMEROPTERA** | *Austroclima* | 7 | 1 | 7 | A | A |
| | *Deleatidium* | 8 | 3 | 20 | | |
| | *Zephlebia group* | 7 | 1 | 7 | | |
| **PLECOPTERA** | *Zelandobius* | 5 | 1 | 7 | | |
| **COLEOPTERA** | Elmidae | 6 | 14 | 93 | VA | VA |
| **TRICHOPTERA** | *Hydropsyche (Aoteapsyche)* | 4 | 14 | 93 | VA | VA |
| | *Hydrobiosis* | 5 | 1 | 7 | | |
| | *Pycnocentrodes* | 5 | 6 | 40 | XA | VA |
| **DIPTERA** | *Aphrophila* | 5 | 6 | 40 | | |
| | *Maoridiamesa* | 3 | 5 | 33 | | |
| | Orthocladiinae | 2 | 13 | 87 | | VA |
| | *Polypedilum* | 3 | 1 | 7 | | A |
| | Tanytarsini | 3 | 1 | 7 | | |
| | *Austrosimulium* | 3 | 2 | 13 | | A |

Prior to the current 2014-2015 period, a moderate number of taxa (19) have characterised the community at this site on occasions due in part to the short duration of monitoring at this site. These have comprised one 'highly sensitive', nine 'moderately sensitive', and nine 'tolerant' taxa i.e. a relatively high proportion of 'tolerant' taxa as would be expected in the lower reaches of a hill-country river. Predominant taxa have included one 'moderately sensitive' taxon [elmid beetles] and four 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Hydropsyche-Aoteapsyche*), and orthoclad midges]. Three of these predominant taxa were dominant in the spring, 2014 community together with two other historically characteristic 'moderately sensitive' taxa. The summer, 2015 community was characterised by four of the taxa dominant in spring, together with one fewer 'tolerant ' taxon and four additional 'tolerant' taxon which previously had been characteristic of this site's communities (Table 117). Increased abundances within three 'tolerant' taxa and a decreased abundance within one 'sensitive' taxon resulted in the 0.7 unit decrease in the summer $SQMCI_s$ score (Tables 172 and 173). The five taxa recorded as very or extremely abundant during spring and/or summer had characterised this site's communities on 40% to 93% 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 a hill country catchment. The 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 2015 data

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has not been performed on the mainly eight years of SEM results collected to date from the site in the Tangahoe River downstream of the railbridge due to the relatively limited data record (i.e. less than ten years). 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.

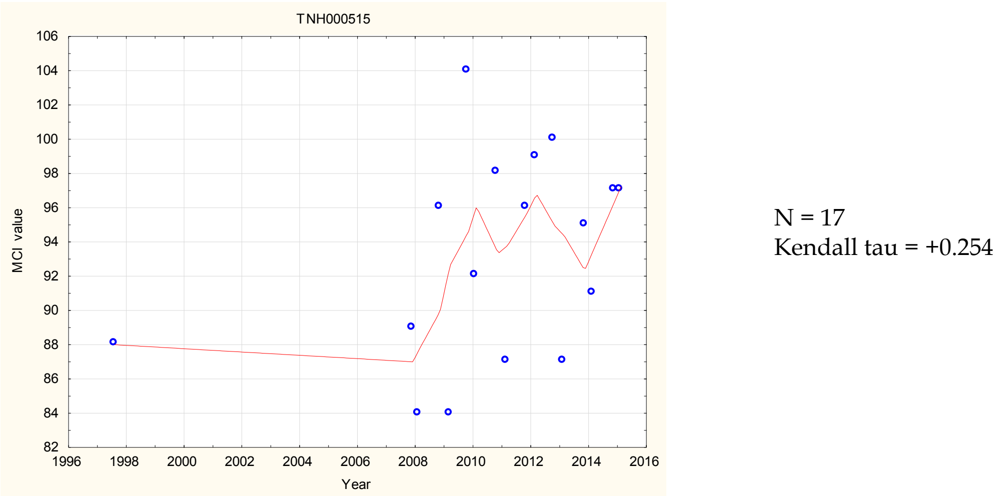



**Figure 113** LOWESS trend plot of MCI data for the Tangahoe River site downstream of the railbridge

An overall temporal trend of improvement in MCI scores may be inferred for this lower river reach, hill country catchment site but no statistical significance will be evaluated until the monitoring period is of sufficient duration. The range of smoothed MCI scores (10 units) has bordered on ecologically important but this importance cannot be properly assessed until the monitoring period is of sufficient duration and frequency for valid interpretation.

Smoothed MCI scores have indicated 'fair' generic river health (Table 1) over the period to date (Figure 113).

### 3.2.24.4 Discussion

Seasonal MCI values increased between spring and summer (by an insignificant 10 units) at the site toward the upper reaches (Upper Tangahoe Valley Road) where historical median seasonal values (Appendix II) have shown a summer increase of five units. At the Tangahoe Valley Road bridge site there was also an atypical summer increase (10 units) which was different to the absence of any historical seasonal median decrease to date. At the railbridge site in the lower reaches, an atypical absence of a summer decrease in MCI score was recorded in comparison with the historical seasonal median decrease of seven units for this site (Appendix II). However, seasonal communities shared only 47% of the 36 taxa found at the upper reach (Upper Tangahoe Valley Road) site, 58% of 38 taxa at the Tangahoe Valley Road bridge site, and 67% of 24 taxa at the furthest downstream site in the lower reaches (railbridge), indicative of increasing similarity in seasonal community composition in a downstream direction, atypical of downstream trends of decreasing seasonal similarity generally found elsewhere.

The spring MCI scores atypically showed an increase (of four units) in a downstream direction over the 8.9 km reach between the upper and mid sites and an increase (by two units) between the upper and lower sites over a distance of 30.2 km (and decrease in elevation of 70 m). This trend was therefore different to 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 eight units) representing an average rate of decrease of 0.26 MCI unit/km or 1.1 MCI unit/10 m, the latter much 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 (0.7 unit/km), between the upper reach (Upper Tangahoe Valley Road) and the mid-reach (Tangahoe Valley Road bridge) sites. The average rate of decline between the mid-reach site and lower reach (railbridge) site has been about 0.5 unit per km with an overall average rate of decline of 0.1 MCI unit/km over the surveyed length of the river. Therefore average rates of MCI decline for the entire river length surveyed over the 2014-2015 period were lower (spring) and higher (summer) than the average median rate for the relatively short monitoring period prior to 2014.

Community composition varied markedly through the upper reach to lower reach length of the river surveyed. A total of 36 taxa was recorded in spring of which only 13 taxa (36%) were present at all three sites (Table 110). These included one 'highly sensitive', five 'moderately sensitive', and seven 'tolerant' taxa with only two 'moderately sensitive' taxa [mayfly (*Austroclima*) and elmid beetles] abundant at all three sites. A higher total of 43 taxa was found along the river's length by the summer survey (Table 111) of which only 14 taxa (33%) were present at all three sites. These included nine of the widespread taxa in spring. Only two 'moderately sensitive' taxa [mayfly (*Austroclima*) and elmid beetles] and one 'tolerant' taxon [net-building caddisfly (*Hydropsyche-Aoteapsyche*)] were abundant at all three sites in summer. These dissimilarities in spatial community structure along the surveyed length (upper reaches to lower reaches) of the Tangahoe River were only slightly more pronounced in summer than in spring.

## 3.2.25 Herekawe Stream

One site in this small lowland coastal ringplain stream on the western perimeter of New Plymouth City was incorporated into the SEM programme in 2008 for the purpose of monitoring a newly-developed walkway and associated riparian planting initiatives in the lower reaches of the stream. Consent monitoring also has been performed at this 'control' site in spring and summer throughout the period from 1995 to 2013 (and dates back to 1986).

The results found by the 2014-2015 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-eight surveys have been undertaken in this lower-reach site in the Herekawe Stream between February 1995 and February 2014. 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 2014 and summer 2015 results

| Site code | SEM data ( 1998 to Feb 2014) | | | | | 2014-2015 surveys | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No of surveys | Taxa numbers | | MCI values | | Oct 2014 | | Feb 2015 | |
| | | Range | Median | Range | Median | Taxa no | MCI | Taxa no | MCI |
| HRK000085 | 38 | 13-23 | 18 | 68-99 | 89 | 19 | 91 | 29 | 92 |

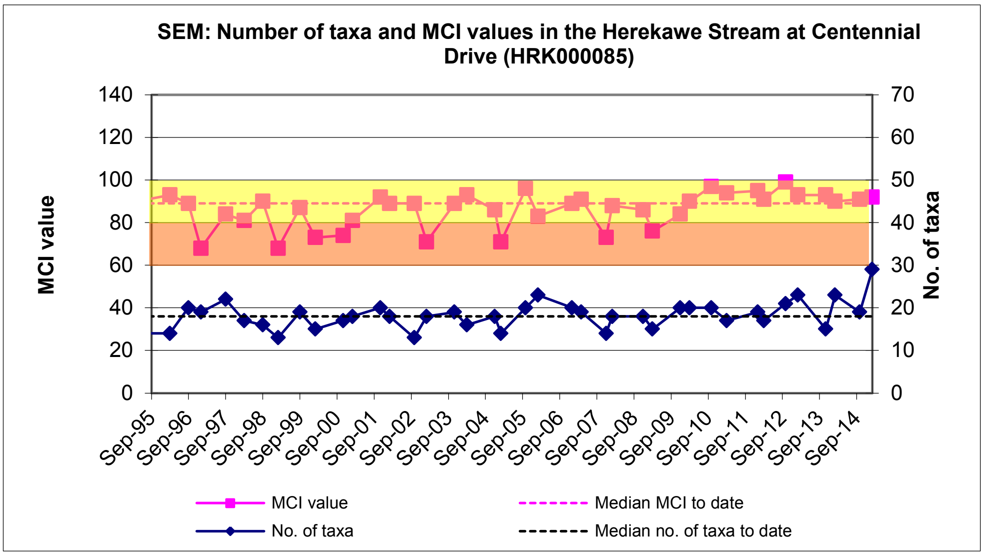



**Figure 114** Numbers of taxa and MCI values in the Herekawe Stream upstream of Centennial Drive

A moderate range of richnesses (13 to 23 taxa) had been found, with a median richness of 18 taxa (more representative of typical richnesses in small lowland coastal streams where a median richness of 17 taxa has been recorded from 194 previous surveys of 'control' sites at similar altitudes (TRC, 2015a). During the 2014-2015 period, spring (19 taxa) and summer (29 taxa) richnesses were dissimilar and from 3 taxa lower to one taxon to 11 taxa higher than this median richness.

MCI values have had a relatively wide range (31 units) at this site. The median value (89 units) is above scores typical of lower reach sites elsewhere in small lowland coastal streams however, and the spring, 2014 (91 units) and summer, 2015 (92 units) scores also were higher than typical for such a site. These were two and three 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 (78 units) recorded by 194 previous surveys of 'control' sites below 25 m asl in small, coastal, lowland streams in Taranaki (TRC, 2015a). The historical median score (89 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 in small lowland coastal streams.

#### 3.2.25.1.2 Community composition

Characteristic macroinvertebrate taxa in the communities at this site prior to the 2014-2015 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 February 2013 [36 surveys], and by the spring 2014 and summer 2015 surveys

| Taxa List | | MCI Score | Total abundances | % of Surveys | Surveys | |
|---|---|---|---|---|---|---|
| | | | | | Spring 2014 | Summer 2015 |
| ANNELIDA | Oligochaeta | 1 | 27 | 71 | A | A |
| MOLLUSCA | *Potamopyrgus* | 4 | 38 | 100 | XA | XA |
| CRUSTACEA | Ostracoda | 1 | 2 | 5 | | |
| | *Paracalliope* | 5 | 32 | 84 | XA | XA |
| EPHEMEROPTERA | *Austroclima* | 7 | 2 | 5 | | |
| | *Coloburiscus* | 7 | 5 | 13 | | |
| PLECOPTERA | *Acroperla* | 5 | 1 | 3 | | |
| | *Megaleptoperla* | 9 | 0 | 0 | | A |
| COLEOPTERA | Elmidae | 6 | 0 | 0 | | VA |
| TRICHOPTERA | *Oxyethira* | 2 | 10 | 26 | | |
| | *Triplectides* | 5 | 12 | 32 | | A |
| DIPTERA | *Aphrophila* | 5 | 2 | 5 | | |
| | Orthocladiinae | 2 | 22 | 58 | A | |
| | *Austrosimulium* | 3 | 13 | 34 | | A |

Prior to the current 2014-2015 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 small, lowland coastal stream.

Predominant taxa have included only the one 'moderately sensitive' taxon [amphipod (*Paracalliope*)] and three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges].

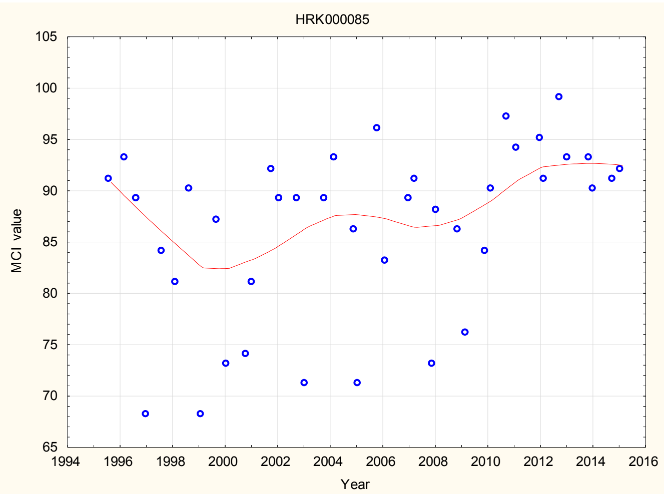
All four of the historically predominant characteristic taxa were dominant in the spring, 2014 community (Table 119). The summer, 2015 community was characterised by three of the same four taxa dominant in spring and one other 'moderately sensitive' taxon and one 'tolerant' taxon together with two 'sensitive' taxa not previously recorded in abundance at this site. [Note: One of these taxa, the 'highly sensitive' stonefly (*Megaleptoperla*), was identified beyond the generic level necessary for MCI purposes, as *M. diminuta* which is the (one of two) species found in slower flowing, vegetated habitats and therefore more likely to be more 'tolerant' (lower MCI tolerance value) of poorer water quality/habitat conditions (Stark & Fowles, 2015)]. Some summer increases in abundances within three 'sensitive' taxa resulted in a small increase in $SQMCI_s$ score from the spring score (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 84% 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. Relationships 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 2015 data

Non- parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the 20 years of 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 = 40
Kendall tau = +0.301
p level = 0.010 [>FDR, p = 0.013]
Significant at p < 0.01 level
N/S at p< 0.01 after FDR

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

The positive temporal trend in MCI scores over the monitoring period is statistically significant at $p < 0.01$ (but not after FDR) at this site in the lower reaches of the stream immediately downstream of the more recently constructed walkway. Trends have varied at this site over the twenty year period with a general trend of improvement since 2000 and particularly after 2008, with more recent stability, but with some wide variations in individual MCI scores. The range of LOWESS-smoothed scores (12 units) has been ecologically important.

Smoothed MCI scores have consistently remained indicative of 'fair' stream health throughout the monitoring period.

#### 3.2.25.2 Discussion

Seasonal MCI values atypically increased between spring and summer (but only by one unit) at this lower reach site which may be compared with the identical median seasonal spring and summer values for the twenty year period (Appendix II). The percentage composition of 'tolerant' taxa typically increased (by 4%) in the summer community although periphyton substrate cover was similar as the cobble composition of the streambed under lower flow conditions. However, seasonal communities at this site shared 14 common taxa (41% of the 34 taxa found at this site in 2014-2015), a relatively low percentage of common taxa.

# 4. General discussion and conclusions

The detection of trends in the biological data requires a data set of suitable period and collected using rigid, acceptable protocols, to be statistically valid e.g., 10 years of spring and summer surveys. With twenty years of data available for most sites, temporal trend analyses have been updated further within this report. Other comments in relation to the data collected in the period 1995 to 2015, are presented briefly below. These data are summarised in Appendix II and illustrated in Figures 116 to 123.

## 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 partial consequence of the former), and finer substrate (sedimentation), coincident with poorer physicochemical water quality 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. Seasonal richnesses often have tended to be higher in summer than in spring , particularly at lower reach sites.

Over the twenty year period, sites in the middle and the lower reaches of streams and rivers generally have had lower summer MCI scores than spring MCI scores as evidenced by overall decreases in median scores by 3 and 5 units respectively, whereas median seasonal scores at upper reach sites have differed by two units on average. This difference has been coincident with summer warmer water temperatures and increased periphyton substrate cover, resulting in the loss of certain 'sensitive' taxa and/or increases in, or replacement by, lower scoring 'tolerant' taxa.

Furthermore, the results from the 2014-2015 period have shown that:

- over all sites, spring MCI scores were slightly higher (by four units) than summer scores but t-testing of the mean seasonal MCI difference showed that this was not significant ($p = 0.20$)
- at upper reach sites there was an increase in average MCI score of less than two units in summer which was statistically insignificant ($p = 0.63$)
- at mid reach sites, a decrease in average MCI score of nearly five units in summer was not significant ($p = 0.21$)
- at lower reach sites, a greater decrease in average MCI score of six units in summer was significant ($p = 0.04$), unlike the insignificant decrease (three units) recorded in the 2013-2014 period
- at all sites, spring 2014 MCI scores were on average four units higher than long term (nineteen year) median scores, but this difference was not significant ($p = 0.19$)

- at all sites, summer 2015 MCI scores were on average within 0.1 unit of long term (nineteen year) median scores, but t-tests showed that this difference was insignificant ($p = 0.98$).

There were only three new maximum MCI site scores (by 1 to 8 units) recorded during the 2014-2015 period. One decrease in historical minimum MCI site score (by 7 units) was recorded during the 2014-2015 period.

### 4.1.1 Spring surveys

#### 4.1.1.1 Historical SEM

Fifty-three (of the 57) sites' faunal communities' spring 2014 MCI scores were either similar to, or better than, historical SEM medians for those sites (Figure 116). Significantly higher scores were found at a small proportion (eight) of mainly mid-reach sites, coincident with these sites having reduced periphyton cover in comparison with many past survey occasions. One significantly lower score was found at a lower reach site at the time of these spring surveys.


**Figure 116** Spring 2013 MCI scores in relation to SEM historical median values

In summary, 84% of sites showed no significant detectable differences (Stark, 1998) between spring, 2014 MCI scores and historical median scores, while 14% of sites had significantly higher and 2% of sites had significantly lower spring 2014 MCI scores.

#### 4.1.1.2 Predictive TRC ringplain altitude/distance models

Predictive scores have been developed for ringplain sites in relation to altitude and distance from the National Park (Stark and Fowles, 2009). Spring scores for each ringplain site have been assessed against predicted scores for altitude in Figure 117 and against predicted scores for distance from the National Park boundary for ringplain sites with their sources inside the National Park in Figure 118.

##### 4.1.1.2.1 Altitude

Few (three) sites had spring MCI scores more than 5 units below predicted values (Figure 117), one of which was significantly lower than predicted. Seventeen sites had spring scores very similar to (within 5 units) predicted scores while the remaining 28 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, a more typical proportion (38% of sites) found to date.


**Figure 117** Spring 2013 MCI scores in relation to predicted altitude scores.

In summary, 60% of sites showed no significant detectable difference (Stark, 1998) between spring, 2014 scores and predicted altitude scores, while 38% of sites had significantly higher spring, 2014 MCI scores and 2% of sites had significantly lower spring, 2014 scores.

#### 4.1.1.2.2 Distance from National Park

Seven sites had spring MCI scores more than 5 units below predicted values (Figure 118) but only one of these sites was 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). Ten sites had spring scores within 5 MCI units of predicted scores while twenty sites' scores were more than 5 units higher than predicted, thirteen of which were significantly higher (> 10 units) than predicted.


**Figure 118** Spring 2014 MCI scores in relation to predicted downstream distance scores

In summary, 63% of sites showed no significant detectable difference (Stark, 1998) between spring, 2014 scores and predicted distance (from the National Park) scores, while 34% of sites had significantly higher spring, 2014 MCI scores and 3% of sites (one site) had a significantly lower spring, 2014 score.

### 4.1.2 Summer surveys

#### 4.1.2.1 Historical SEM

A majority (51 of 57 sites) of sites' faunal communities' MCI scores were similar to (within 10 units) historical SEM site median scores (Figure 119). Significantly higher scores were found at only two sites, while four sites showed significantly lower MCI scores during summer, relatively low flow conditions in the region.

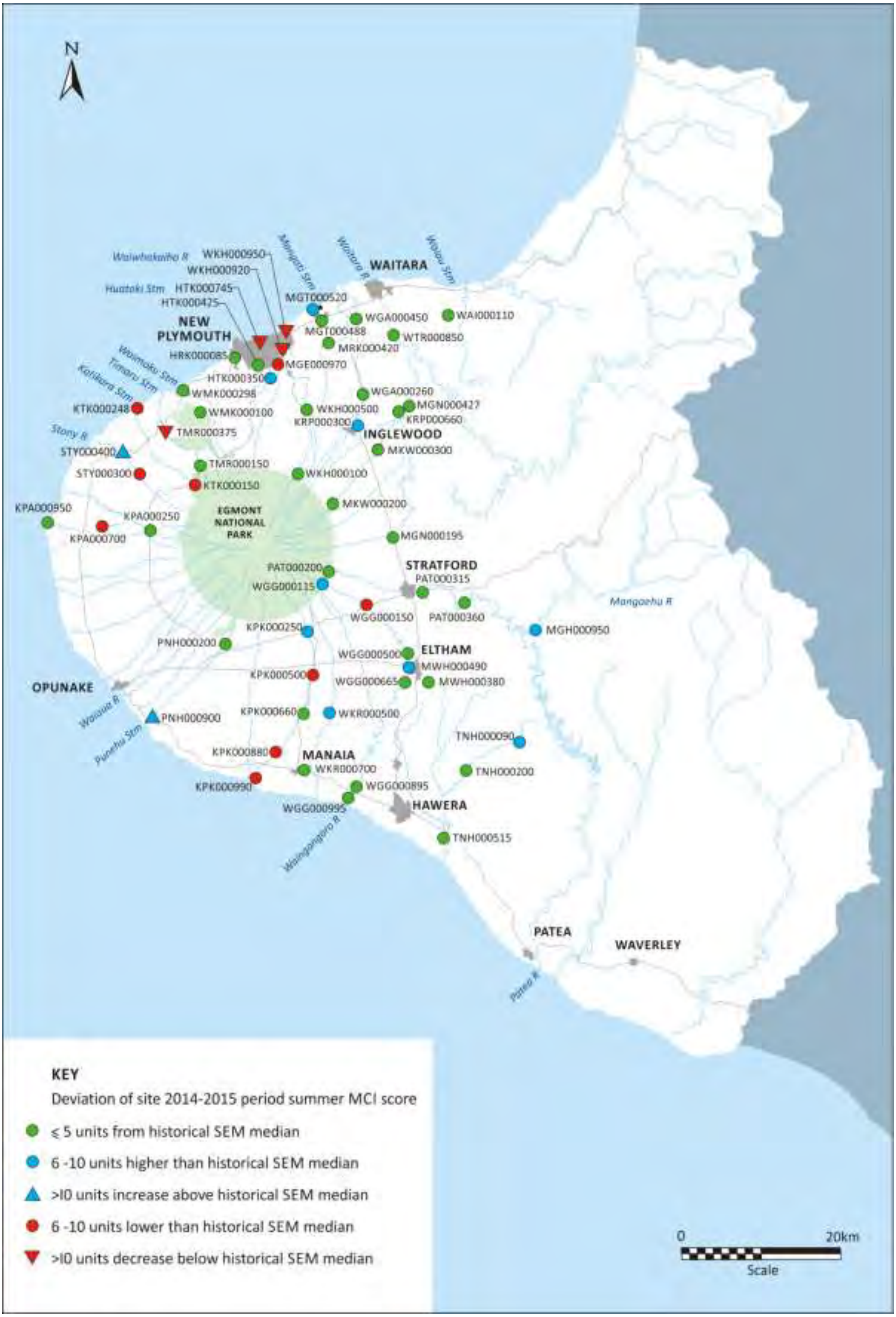



**Figure 119** Summer 2014 MCI scores in relation to SEM historical median values

Significantly higher scores were found in the lower reaches of the Stony River and Punehu Stream. The four significantly lower scores were found in the mid reaches of the Timaru Stream (see Section 3.2.20.1) and lower reaches of the Waiwhakaiho River (two sites) and Huatoki Stream.

In summary, 89% of sites showed no significant detectable differences (Stark, 1998) between summer, 2015 MCI scores and historical median scores, while 4% of sites had significantly higher summer, 2015 scores and 7% of sites had significantly lower summer 15 scores.

Fewer sites (10%) had significantly higher MCI scores (than historical medians) in summer than spring whereas and spring by four summer sites' scores (7% of sites) were significantly lower than historical medians. In summer, 23% of sites were 6 or more MCI units lower than historical medians compared to 7% in spring. In summer 18% of sites' scores were greater than 5 MCI units higher than historical medians compared to 37% of sites in spring, a relatively typical historical seasonal trend.

#### 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 121).

#### 4.1.2.2.1 Altitude


**Figure 120** Summer 2015 MCI scores in relation to predicted altitude scores

Nine sites had summer MCI scores greater than 5 units below predicted values, one of which (Mangawhero Stream near the Waingongoro River confluence) is downstream of the more recently diverted Eltham municipal wastewater point source discharge. This site and sites in the lower reaches of the Huatoki Stream and mid reaches of the Kapoaiaia Stream and Waingongoro River were the only sites significantly below predictive values. Twenty-three sites had scores very similar to (within 5 units) predicted scores (Figure 120), while sixteen 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 Kaupokonui, Huatoki, and Punehu Streams and Stony, River; and in the lower reaches of the Punehu Stream and Stony River.

In summary, 74% of sites showed no significant detectable difference (Stark, 1998) between summer, 2015 scores and predicted altitude scores, while 17% of sites had significantly higher summer MCI scores and 9% of sites had significantly lower summer MCI scores. A typically higher proportion of sites significantly exceeded the predictive scores in spring (21% more) to those in summer while there was a 2% increase in sites with seasonally significant lower scores in summer.

#### 4.1.2.2.2 Distance from National Park

Nine sites (two more than in spring) had summer MCI score more than 5 units below predicted values (Figure 122) with seven of these sites' scores (in the lower reaches of the Waimoku, Kapoaiaia, and Kaupokonui Streams and Waiwhakaiho River (two sites) ; and mid reaches of the Timaru and Kapoaiaia Streams) significantly lower than predicted. Fourteen sites had summer scores within 5 units of predicted scores, while twelve sites' scores (nine fewer sites than in spring) were more than 5 units higher than predicted. There were six sites with summer scores significantly higher than predicted, seven sites fewer than in spring. These sites were situated in the upper reaches of the Patea River; mid reaches of the Manganui and Waingongoro Rivers, and Punehu and Kaupokonui Streams; and lower reaches of the Stony River (Figure 121).

In summary, 67% of sites showed no significant detectable difference (Stark, 1998) between summer, 2015 MCI scores and predicted distance (from National Park) scores, while 15% of sites had significantly higher summer scores and 18% of sites had significantly lower summer scores. A much higher proportion (by 19%) of sites' scores significantly exceeded predictive scores in spring while a greater proportion (by 15%) of sites' scores were significantly worse in summer.


**Figure 121** Summer 2015 MCI scores in relation to predicted downstream distance 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 2014 | | | Summer 2015 | | |
|---|---|---|---|---|---|---|
| Prediction | > 10 units lower | ± 10 units | > 10 units higher | > 10 units lower | ± 10 units | > 10 units higher |
| Altitude<br>Distance | 2<br>3 | 60<br>63 | 38<br>34 | 9<br>18 | 74<br>67 | 17<br>15 |

In general, while there were marked seasonal differences between seasons in sites' percentages of scores falling significantly below predicted scores (up to 2% fewer in spring), there was a greater decrease by 21% of sites' scores significantly exceeding predicted scores during the summer survey, the latter of which has been typical of seasonal trend reported for most SEM annual surveys to date [and more pronounced than in the previous 2013-2014 period (TRC, 2014)].

#### 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), have had historical 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 Lucy's Gully and 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 selection of 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 (1981 to 2006) macroinvertebrate 'control' sites database for the entire ringplain.

### 4.1.3 SEM MCI in relation to various 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.

Median MCI scores from the twenty year SEM period (1995-2015) have been compared with the REC predictions for all 57 sites in Figure 123 and in Appendix II.


Figure 122 SEM historical (1995-2014) median values in relation to REC predictive values

Overall, this comparison indicates that only four sites (7%) have had median scores more than 5 units above the REC predictions, one of which is in the small Katikara Stream, and the others in the upper reaches of the Patea and Waingongoro Rivers and in the mid reaches of the Huatoki Stream (within the riparian vegetation of the Huatoki Domain, New Plymouth). Twenty-seven sites (47%) were within five MCI units of predicted scores and 46% of sites (26) were more than five units below predicted REC scores. Of these lower scores, 15 sites had scores significantly lower than REC predictions with these situated in the mid reaches of the Kurapete, Timaru, Mangawhero, and Kaupokonui Streams, and the Stony, Patea and Tangahoe Rivers; and the lower reaches of the Mangati, Waimoku, Kapoaiaia, Mangawhero, Punehu, and Kaupokonui Streams and the Waitara and Mangaehu Rivers. In terms of the 2014-2015 survey period (Appendix II); during spring, five sites significantly exceeded REC predictions while ten sites had significantly lower MCI scores; and during summer, only two sites significantly exceeded the REC predictive scores while fourteen scores were significantly lower than predicted.

The MCI scores from the twenty year duration (1995-2015) 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** Percentages of sites withmedian SEM scores (1995-2015) showing significant differences (> 10 MCI units) from the various predicted scores

| Sites | Deviation from predicted scores | | | | | |
|---|---|---|---|---|---|---|
| | Altitude[1] | | Distance[1] | | REC[2] | |
| | Lower | Higher | Lower | Higher | Lower | Higher |
| Upper reaches | 0% | 28% | 0% | 14% | 0% | 0% |
| Mid reaches | 5% | 10% | 0% | 19% | 20% | 4% |
| Lower reaches | 5% | 10% | 7% | 0% | 36% | 0% |
| All sites | 4% | 13% | 3% | 11% | 25% | 2% |

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

In summary, 17% 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. 14% of sites' median scores differed significantly from predictions based on distance from the National Park boundary with a greater proportion higher than predicted although there was a marked downstream difference with none sited in the lower reaches. No individual site's median MCI score differed significantly from both 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 higher proportion of lower catchment sites had lower median scores than predicted by distance.

Only one median MCI score (Huatoki Stream at the Domain, New Plymouth) significantly exceeded predicted scores based upon the REC system, whereas 25% of sites' scores were significantly lower, increasing in a downstream direction from none in the upper reaches through 20% in the mid reaches to 36% of sites in the lower reaches. Interestingly, relatively few sites' median scores exceeded the REC predictions in any reaches (seventeen sites in total and most only by a few MCI units). It should be noted that SEM median MCI scores effectively incorporate equal proportions of spring and summer scores and that the maximum scores for each site (over the 1995 to 2015 period) (invariably recorded in spring) have often exceeded the REC predicted scores. Those sites where maximum scores have remained five 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 twenty years to date has significantly (11 units or more) exceeded the REC predicted scores (44%) includes 20% of sites located in the lower reaches of catchments.[Note: This exceedance increased by 4% (one site) over the 2014-2015 period].

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 twenty 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 best and poorest sites in the SEM programme.

**Table 122** Ranking of sites' median MCI scores (1995-2015) based on deviation from predictive scores

| | Distance from National Park | REC |
|---|---|---|
| BEST | Waingongoro R @ Opunake Rd (m) | Huatoki S @ Domain (m) |
| | Manganui R. SH3 (m) | Patea R @ Barclay Rd (u) |
| | Patea R @ Barclay Rd (u) | Waingongoro R @ Opunake Rd (m) |
| | Kaupokonui S @ Opunake Rd (u) | Katikara S @ coast (l) |
| | Waingongoro R @ SH45 (l) | Katikara S @ Carrington Rd (u) |
| | Kaupokonui R @ d/s Kaponga (m) | Waingongoro R @ SH45 (1) |
| POOREST | Waimoku S @ coast (l) | Mangawhero S @ Eltham (m) |
| | Kapoaiaia S @ coast (l) | Mangaehu Rd @ Raupuha Rd (l) |
| | Punehu S @ SH 45 (l) | Mangawhero S @ d/s of Mangawharawhara S. (l) |
| | Kapoaiaia S @ Wataroa Rd (m) | Timaru S @ SH 45 (l) |
| | | Mangati S @ Bell Block (l) |
| | | Kaupokonui S @ Glenn Road (l) |
| | | Kaupokonui S @ u/s Lactose (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. 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 used to and/or continue to, 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 twenty year period (1995-2015). These assessments are summarised in Appendix II and illustrated in Figure 123. The 'health' of streams in relation to the location of sites (upper, middle and lower reaches) in catchments is summarised in Table 123.

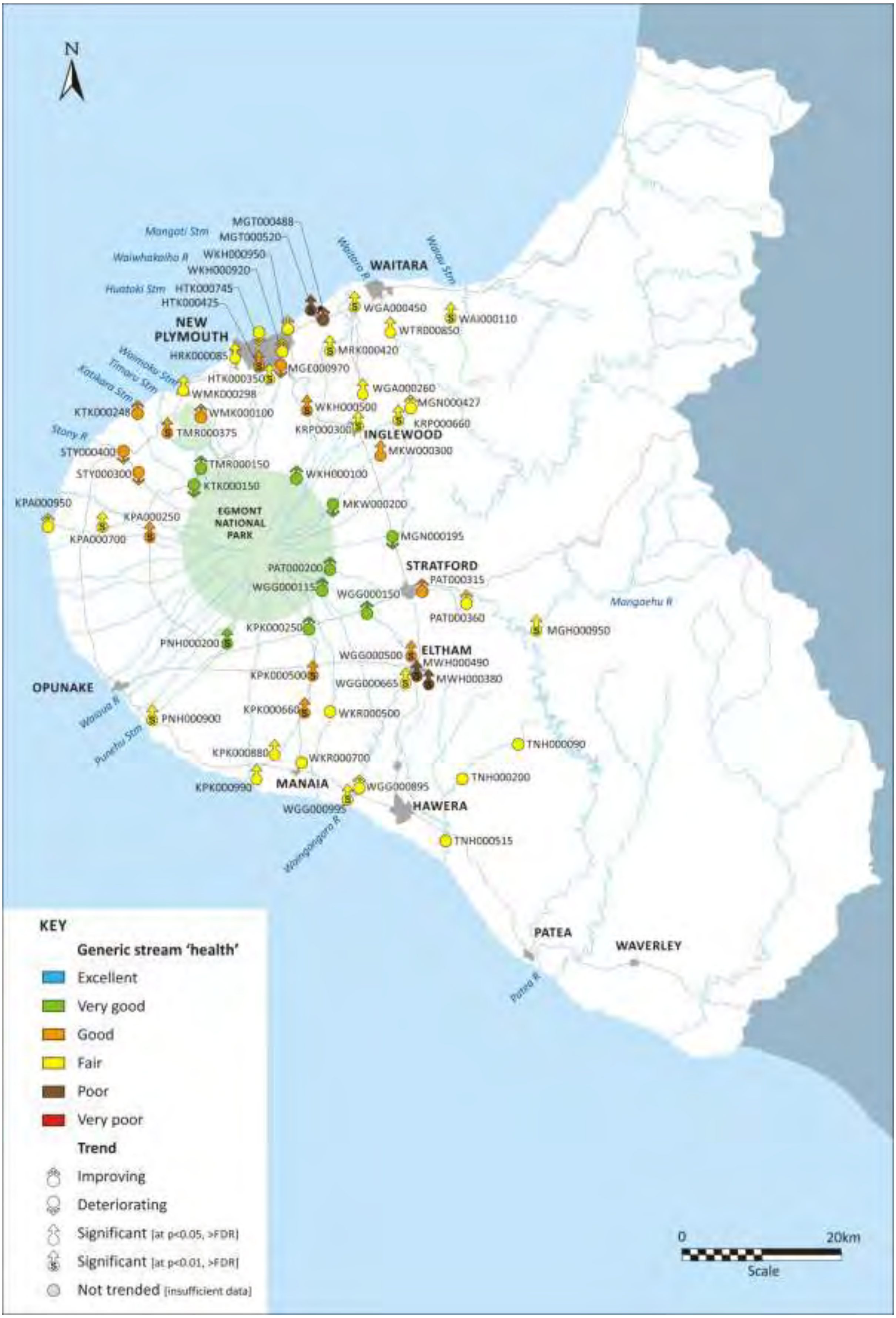



**Figure 123** Generic biological 'health' (based on median MCI) and trends in biological quality for SEM sites, 1995 to 2014

**Table 123** Stream 'health' siteassessments according to 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 | 5 |
| Fair | 0 | 10 | 18 |
| Poor | 0 | 2 | 2 |
| Very poor | 0 | 0 | 0 |
| Predictive (Table 2)* | | | |
| Better than expected | 0 | 2 | 1 |
| Expected | 7 | 18 | 19 |
| Worse than expected | 0 | 1 | 0 |
| Median ranges* (MCI units) | 127-138 (11) | 90-130 (40) | 79-104 (25) |

(* = ringplain sites only)

Typically generic 'health' (in terms of median MCI scores) decreases in a downstream direction from 'very good' in the upper reaches of catchments, through predominantly 'good-fair' in the middle reaches, to mainly 'fair' in the lower reaches toward the coast (Figure 123). In terms of predictive 'health', all but one of the gradings have varied between 'better than expected' and 'expected' through all reaches. Very few sites had 'better than expected' 'health' or fell below 'expected' amongst the sites assessed. Each site's 'health' may vary between seasons, but seldom by no more than one category (grading) either side of this median grading in response to preceding stream flow and associated habitat (physical and physicochemical water quality) conditions. In this regard generally there has been 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 change in macroinvertebrate communities towards those that are comprised of taxa more 'tolerant' of organic enrichment and/or physical habitat deterioration in the lower reaches. These communities have become well adapted to the cumulative impacts of upstream point source discharges and 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 less likely to be of statistical significance and ecological significance i.e. important (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 and/or important until appropriate management initiatives are substantially progressed on a catchment wide basis. Enhancement of stream health, particularly at these sites in the lower reaches of ringplain streams, is unlikely to be significant and/or important until marked improvements in habitat and water quality occur. These may be implemented for instance by way of a combination of riparian fencing/planting initiatives and re-direction of dairy pond treatment system discharges from direct disposal into surface waters to irrigation to land.

## 4.2 Macroinvertebrate fauna MCI trends

Temporal trends measured over the monitoring period between 1995 and 2014 (Table 124, Figure 123, and Appendix II) indicated that 44 sites showed improving MCI scores during the period, 8 sites deteriorating scores, and five sites could not be trended due to the shorter duration of monitoring at these sites.

**Table 124** Summary of Mann-Kendall test results for MCI (stream 'health') scores trended over time (1995-2014) for 52 Taranaki streams/rivers (p without FDR applied)

| Site code | N | p-level | +/-(ve) | Significance |
|---|---|---|---|---|
| STY000300 | 41 | 0.082 | -ve | N/S |
| STY000400 | 41 | 0.807 | -ve | N/S |
| TMR000150 | 38 | 0.217 | +ve | N/S |
| TMR000375 | 38 | <0.0001 | +ve | signif* |
| MRK000420 | 38 | <0.0001 | +ve | signif* |
| WGA000260 | 39 | 0.039 | +ve | signif |
| WGA000450 | 38 | <0.0001 | +ve | signif* |
| WKH000100 | 24 | 0.531 | +ve | N/S |
| WKH000500 | 38 | 0.002 | +ve | signif* |
| WKH000920 | 39 | 0.501 | +ve | N/S |
| WKH000950 | 37 | 0.567 | +ve | N/S |
| MGE000970 | 24 | 0.074 | -ve | N/S |
| MGN000195 | 40 | 0.458 | -ve | N/S |
| MGN000427 | 38 | 0.226 | +ve | N/S |
| MKW000200 | 29 | 0.756 | -ve | N/S |
| MKW000300 | 28 | 0.005 | +ve | signif |
| WTR000850 | 38 | 0.020 | +ve | signif |
| MGT000488 | 39 | 0.241 | +ve | N/S |
| MGT000520 | 39 | <0.0001 | +ve | signif* |
| WMK000100 | 30 | 0.920 | +ve | N/S |
| WMK000298 | 30 | 0.010 | +ve | signif |
| WAI000110 | 31 | 0.001 | +ve | signif* |
| PNH000200 | 38 | 0.002 | +ve | signif* |
| PNH000900 | 38 | <0.0001 | +ve | signif* |
| PAT000200 | 38 | 0.531 | +ve | N/S |
| PAT000315 | 38 | 0.161 | +ve | N/S |
| PAT000360 | 38 | 0.191 | +ve | N/S |
| MGH000950 | 38 | <0.0001 | +ve | signif* |
| WGG000115 | 39 | 0.219 | +ve | N/S |
| WGG000150 | 39 | 0.534 | +ve | N/S |
| WGG000500 | 42 | <0.0001 | +ve | signif* |
| WGG000665 | 38 | <0.0001 | +ve | signif* |
| WGG000895 | 39 | 0.075 | +ve | N/S |
| WGG000995 | 38 | 0.001 | +ve | signif* |
| MWH000380 | 38 | 0.002 | +ve | signif* |
| MWH000490 | 38 | <0.0001 | +ve | signif* |
| HTK000350 | 36 | <0.0001 | +ve | signif* |
| HTK000425 | 36 | 0.0002 | +ve | signif* |
| HTK000745 | 36 | 0.878 | -ve | N/S |
| KPK000250 | 31 | 0.597 | + ve | N/S |
| KPK000500 | 34 | <0.0002 | +ve | signif* |
| KPK000660 | 38 | <0.0001 | +ve | signif* |
| KPK000880 | 38 | 0.013 | +ve | signif* |
| KPK000990 | 20 | 0.010 | +ve | signif |
| KTK000150 | 30 | 0.071 | -ve | N/S |
| KTK000248 | 29 | 0.356 | +ve | N/S |
| KPA000250 | 30 | <0.0001 | +ve | signif* |
| KPA000700 | 30 | <0.001 | +ve | signif* |
| KPA000950 | 30 | 0.122 | +ve | N/S |
| KRP000300 | 39 | <0.0001 | +ve | signif* |
| KRP000660 | 39 | <0.0001 | +ve | signif* |
| WKR000500 | - | - | - | - |
| WKR000700 | - | - | - | - |
| TNH000090 | - | - | - | - |
| TNH000200 | - | - | - | - |
| TNH000515 | - | - | - | - |
| HRK000085 | 38 | 0.006 | +ve | signif |

[N/S = not statistically significant (ie p≥0.05),= significant before FDR (at p<0.05); = significant after FDR applied (at p < 0.05; * p< 0.01); -ve = negative trend, +ve = positive trend]

The majority of these trends were not statistically significant (at p <0.01 after FDR) for the monitoring period (see also Appendix II). The following is a summary of trends for the SEM period to date:

– twenty-two sites with a positive very significant trend (p<0.01 after FDR)
– nine additional sites with a positive trend (p<0.05) but not significant (p>0.01 seven FDR)
– no sites with a significant negative trend (p<0.05)

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 1995-2014 [significant trend at p<0.05 and p<0.01]

| Site | Valid N | p-level | p-value (FDR corrected) | Trend | Ecological importance (LOWESS-smoothed MCI range) |
|---|---|---|---|---|---|
| KRP000300 | 41 | <<0.0001 | <<0.0001 | +ve | moderate, 19 units |
| KPK000660 | 40 | <<0.0001 | <<0.0001 | +ve | high, 33 units |
| MGH000950 | 40 | <<0.0001 | <<0.0001 | +ve | high, 20 units |
| HTK000350 | 38 | <<0.0001 | <<0.0001 | +ve | moderate, 15 units |
| KPA000250 | 32 | <<0.0001 | <<0.0001 | +ve | high, 30 units |
| MGT000520 | 41 | <<0.0001 | <<0.0001 | +ve | high, 21 units |
| PNH000900 | 40 | <<0.0001 | <<0.0001 | +ve | high, 24 units |
| MWH000490 | 40 | <<0.0001 | <<0.0001 | +ve | high, 22 units |
| MRK000420 | 40 | <<0.0001 | <<0.0001 | +ve | moderate, 15 units |
| WGG000500 | 44 | <<0.0001 | <0.001 | +ve | low, 10 units |
| KRP000660 | 41 | <<0.0001 | <0.001 | +ve | high, 24 units |
| KPK000500 | 36 | <0.001 | <0.001 | +ve | high, 20 units |
| TMR000375 | 40 | <0.001 | <0.001 | +ve | moderate, 18 units |
| HTK000425 | 38 | 0.0002 | <0.001 | +ve | low, 10 units |
| WGA000450 | 40 | 0.0003 | 0.001 | +ve | moderate, 18 units |
| KPA000700 | 32 | 0.0006 | 0.002 | +ve | high, 22 units |
| WGG000665 | 40 | 0.0009 | 0.003 | +ve | moderate, 12 units |
| WAI000110 | 33 | 0.0013 | 0.004 | +ve | low, 9 units |
| WGG000995 | 40 | 0.0015 | 0.004 | +ve | moderate, 15 units |
| MWH000380 | 40 | 0.0018 | 0.004 | +ve | low, 6 units |
| WKH000500 | 40 | 0.0018 | 0.004 | +ve | moderate, 14 units |
| PNH000200 | 40 | 0.0021 | 0.005 | +ve | moderate, 16 units |
| MKW000300 | 30 | 0.0049 | 0.011 | +ve | moderate, 17 units |
| HRK000085 | 40 | 0.0062 | 0.014 | +ve | moderate, 11 units |
| KPK000990 | 32 | 0.0095 | 0.020 | +ve | moderate, 14 units |
| WMK000298 | 32 | 0.010 | 0.020 | +ve | low, 9 units |
| KPK000880 | 40 | 0.013 | 0.026 | +ve | moderate, 15 units |
| WTR000850 | 40 | 0.020 | 0.037 | +ve | moderate, 18 units |

Each of these site's trends is discussed more fully earlier in the report. In general, all but one of these sites exhibited MCI score variabilities over the nineteen year SEM monitoring period which were ecologically significant, with seven sites showing variability of high ecological significance. Those sites with the strongest positive temporal improvement over the 20 year monitoring period, coupled with very improvement ecological variability, have been:

– Kaupokonui Stream upstream of Fonterra, Kapuni factory
– Mangaehu River at Raupuha Road
– Punehu Stream at SH45

- Kapoaiaia Stream at Wiremu Road
- Mangawhero Stream upstream of Waingongoro River confluence
- Kaupokonui Stream upstream of Kaponga WWTP
- Kapoaiaia Stream at Wataroa Road
- Mangati Stream at Bell Block

Four of these sites have illustrated particularly strong improvements over the most recent five to nine year period.

Slightly lower positive temporal improvements, but important ecological improvement have been shown at the following sites:

- Timaru Stream at SH45
- Huatoki Stream at Hadley Drive
- Waiongana Stream at SH3
- Mangaoraka Stream at Corbett Road
- Kurapete Stream upstream of Inglewood WWTP
- Waiwhakaiho River at SH 3
- Waingongoro River at Stuart Road
- Waingongoro River at SH45

It is noted that although three Waingongoro River sites [at Eltham (upstream of the two former major point source discharges) and downstream at Stuart Road and at Ohawe Beach] have shown significant positive trends ($p<0.01$), the sites downstream of these former point source discharges have shown slightly greater ecological improvement.

# 5. Summary

These twentieth spring and summer biomonitoring components of the established SEM programme were performed during the period between early October 2014 and February to mid March 2015 respectively. This report describes the macroinvertebrate fauna and microflora communities at 57 sites established through the Taranaki region (TRC, 1995b). These include the additional riparian monitoring sites in the Katikara and Kapoaiaia Streams and the sites in the Maketawa Stream and Waiwhakaiho catchment with the two sites monitored for consent purposes in the Kurapete Stream also included. Sites in the Waiokura Stream and Tangahoe River were also added to the programme in the 2007-2008 period and a site in the lower Herekawe Stream in 2008-2009 (although this site has a lengthy historical consent monitoring record spanning the 1995 to 2008 period). 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 2006c and TRC 2015a) where applicable and also in relation to more recently established relationships between site altitude and distance from the National Park (Stark and Fowles, 2009) and the REC system (J Leathwick, pers comm.). Discussion of temporal trends over the twenty years of data collection is also provided for each site and causal assessments have been made where trends have been shown to be statistically significant and particularly where ecological importance has been high.

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

# 6. Recommendations from the 2013-2014 report

In the 2013-2014 report, it was recommended:-

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2014-2015 monitoring year by means of a similar programme to that undertaken in 2013-2014.

2. THAT temporal trending of the macroinvertebrate faunal data be updated on an annual basis.

The programme followed Recommendation 1 in the 2014-2015 monitoring year and the temporal trend reporting was undertaken and included in the Annual Report.

# 7. Recommendations for 2015-2016

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2015-2016 monitoring year by means of the same programme to that undertaken in 2014-2015 and expanded to include two additional sites (one in each of the lower reaches of the Waitara and Whenuakura Catchments) representative of large hill-country catchments.
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

# 8. Acknowledgements

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# Appendix I

# Macroinvertebrate faunal 2014-2015 tables

**Table 126** Macroinvertebrate fauna of the Stony River: spring SEM survey sampled on 7 January 2015

| Taxa list | Site Code | | STY000300 | STY000400 |
|---|---|---|---|---|
| | Sample Number | | FWB15001 | FWB15002 |
| **EPHEMEROPTERA (MAYFLIES)** | *Deleatidium* | 8 | VA | XA |
| **PLECOPTERA (STONEFLIES)** | *Zelandoperla* | 8 | C | C |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C | C |
| | *Costachorema* | 7 | C | A |
| | *Hydrobiosis* | 5 | - | C |
| **DIPTERA (TRUE FLIES)** | Eriopterini | 5 | R | R |
| | *Maoridiamesa* | 3 | R | R |
| | Orthocladiinae | 2 | R | A |
| | | **No of taxa** | 8 | 9 |
| | | **MCI** | 108 | 107 |
| | | **SQMCIs** | 7.4 | 7.6 |
| | | **EPT (taxa)** | 4 | 5 |
| | | **%EPT (taxa)** | 50 | 56 |
| 'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa | | |

**Table 127** Macroinvertebrate fauna of the Stony River: summer SEM survey sampled on 24 March 2015

| Taxa List | Site Code | | STY000300 | STY000400 |
|---|---|---|---|---|
| | Sample Number | | FWB15207 | FWB15208 |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | R | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Deleatidium* | 8 | XA | XA |
| | *Nesameletus* | 9 | R | R |
| **PLECOPTERA (STONEFLIES)** | *Zelandoperla* | 8 | A | R |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A | A |
| | *Costachorema* | 7 | C | R |
| | *Hydrobiosis* | 5 | C | R |
| | *Psilochorema* | 6 | R | R |
| | *Pycnocentrodes* | 5 | R | - |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | C | - |
| | Eriopterini | 5 | C | R |
| | *Maoridiamesa* | 3 | R | - |
| | Orthocladiinae | 2 | R | R |
| | | **No of taxa** | 14 | 10 |
| | | **MCI** | 106 | 120 |
| | | **SQMCIs** | 7.7 | 7.8 |
| | | **EPT (taxa)** | 8 | 7 |
| | | **%EPT (taxa)** | 57 | 70 |
| '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 7 January 2015

| Taxa List | Site Code | | TMR000150 | TMR000375 |
|---|---|---|---|---|
| | Sample Number | | FWB15003 | FWB15004 |
| ANNELIDA (WORMS) | Oligochaeta | 1 | - | C |
| MOLLUSCA | *Potamopyrgus* | 4 | - | C |
| EPHEMEROPTERA (MAYFLIES) | *Acanthophlebia* | 9 | R | - |
| | *Ameletopsis* | 10 | R | - |
| | *Austroclima* | 7 | C | R |
| | *Coloburiscus* | 7 | VA | C |
| | *Deleatidium* | 8 | XA | - |
| | *Nesameletus* | 9 | A | - |
| | *Rallidens* | 9 | - | C |
| PLECOPTERA (STONEFLIES) | *Austroperla* | 9 | C | - |
| | *Megaleptoperla* | 9 | A | - |
| | *Stenoperla* | 10 | R | - |
| | *Taraperla* | 10 | R | - |
| | *Zelandobius* | 5 | C | - |
| | *Zelandoperla* | 8 | VA | R |
| COLEOPTERA (BEETLES) | Elmidae | 6 | A | C |
| | Hydraenidae | 8 | R | R |
| | Hydrophilidae | 5 | - | R |
| | Ptilodactylidae | 8 | R | - |
| | Staphylinidae | 5 | R | - |
| MEGALOPTERA (DOBSONFLIES) | *Archichauliodes* | 7 | A | A |
| TRICHOPTERA (CADDISFLIES) | *Hydropsyche (Aoteapsyche)* | 4 | R | A |
| | *Costachorema* | 7 | C | C |
| | *Hydrobiosis* | 5 | - | C |
| | *Hydrobiosella* | 9 | R | - |
| | *Neurochorema* | 6 | - | C |
| | *Psilochorema* | 6 | R | - |
| | *Beraeoptera* | 8 | C | R |
| | *Helicopsyche* | 10 | C | - |
| | *Olinga* | 9 | A | - |
| | *Oxyethira* | 2 | - | C |
| | *Pycnocentria* | 7 | R | R |
| | *Pycnocentrodes* | 5 | R | A |
| | *Zelolessica* | 7 | R | - |
| DIPTERA (TRUE FLIES) | *Aphrophila* | 5 | A | A |
| | Eriopterini | 5 | R | - |
| | *Maoridiamesa* | 3 | C | A |
| | Orthocladiinae | 2 | C | A |
| | Tanypodinae | 5 | R | - |
| | Tanytarsini | 3 | - | C |
| | Dolichopodidae | 3 | R | - |
| | Empididae | 3 | - | C |
| | Muscidae | 3 | - | R |
| | *Austrosimulium* | 3 | - | A |
| | | No of taxa | 33 | 25 |
| | | MCI | 139 | 102 |
| | | SQMCIs | 7.7 | 4.4 |
| | | EPT (taxa) | 22 | 11 |
| | | %EPT (taxa) | 67 | 44 |
| '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 24 March 2015

| Taxa List | Site Code | | TMR000150 | TMR000375 |
|---|---|---|---|---|
| | Sample Number | | FWB15209 | FWB15210 |
| **PLATYHELMINTHES (FLATWORMS)** | *Neppia* | 6 | R | - |
| **NEMERTEA** | Nemertea | 3 | - | R |
| **NEMATODA** | Nematoda | 3 | - | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | C |
| | Lumbricidae | 5 | - | R |
| **MOLLUSCA** | *Potamopyrgus* | 4 | - | A |
| **EPHEMEROPTERA (MAYFLIES)** | *Acanthophlebia* | 9 | C | - |
| | *Ameletopsis* | 10 | R | - |
| | *Austroclima* | 7 | - | C |
| | *Coloburiscus* | 7 | VA | A |
| | *Deleatidium* | 8 | VA | - |
| | *Nesameletus* | 9 | C | - |
| | *Zephlebia group* | 7 | R | - |
| **PLECOPTERA (STONEFLIES)** | *Austroperla* | 9 | C | - |
| | *Megaleptoperla* | 9 | C | - |
| | *Stenoperla* | 10 | R | - |
| | *Zelandobius* | 5 | C | - |
| | *Zelandoperla* | 8 | C | R |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | A |
| | Hydraenidae | 8 | R | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A | VA |
| | *Costachorema* | 7 | R | - |
| | *Hydrobiosis* | 5 | R | A |
| | *Neurochorema* | 6 | R | C |
| | *Psilochorema* | 6 | R | - |
| | *Beraeoptera* | 8 | A | R |
| | *Confluens* | 5 | - | C |
| | *Olinga* | 9 | A | - |
| | *Oxyethira* | 2 | - | A |
| | *Pycnocentria* | 7 | - | C |
| | *Pycnocentrodes* | 5 | - | A |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | C |
| | *Maoridiamesa* | 3 | - | A |
| | Orthocladiinae | 2 | A | A |
| | *Polypedilum* | 3 | R | - |
| | Tanytarsini | 3 | - | A |
| | Empididae | 3 | - | C |
| | Muscidae | 3 | - | A |
| | *Austrosimulium* | 3 | - | C |
| **ACARINA (MITES)** | Acarina | 5 | - | R |
| | | **No of taxa** | 25 | 26 |
| | | **MCI** | 138 | 92 |
| | | **SQMCIs** | 6.9 | 4.3 |
| | | **EPT (taxa)** | 18 | 10 |
| | | **%EPT (taxa)** | 72 | 38 |
| '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 23 October 2014

| Taxa List | Site Code | MCI score | MRK000420 |
|---|---|---|---|
| | Sample Number | | FWB14332 |
| **NEMERTEA** | Nemertea | 3 | R |
| **NEMATODA** | Nematoda | 3 | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | A |
| **MOLLUSCA** | *Latia* | 5 | R |
| | *Potamopyrgus* | 4 | C |
| **CRUSTACEA** | Ostracoda | 1 | R |
| | *Paracalliope* | 5 | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C |
| | *Coloburiscus* | 7 | R |
| | *Deleatidium* | 8 | C |
| **PLECOPTERA (STONEFLIES)** | *Zelandobius* | 5 | A |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | VA |
| | *Costachorema* | 7 | C |
| | *Hydrobiosis* | 5 | A |
| | *Neurochorema* | 6 | C |
| | *Oxyethira* | 2 | R |
| | *Pycnocentria* | 7 | C |
| | *Pycnocentrodes* | 5 | R |
| | *Triplectides* | 5 | R |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | C |
| | *Maoridiamesa* | 3 | A |
| | Orthocladiinae | 2 | C |
| | Tanytarsini | 3 | C |
| | Empididae | 3 | R |
| | *Austrosimulium* | 3 | A |
| | | **No of taxa** | 27 |
| | | **MCI** | 90 |
| | | **SQMCIs** | 4.7 |
| | | **EPT (taxa)** | 11 |
| | | **%EPT (taxa)** | 41 |
| '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, 2014-2015 and historical MCI scores, predicted scores and 1995-2015 trends

**Table 131** Macroinvertebrate fauna of the Mangaoraka Stream: summer SEM survey sampled on 11 February 2015

| Taxa List | Site Code | MCI score | MRK000420 |
|---|---|---|---|
| | Sample Number | | FWB15080 |
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | R |
| **NEMERTEA** | Nemertea | 3 | A |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | A |
| **MOLLUSCA** | *Latia* | 5 | R |
| | *Potamopyrgus* | 4 | VA |
| | Sphaeriidae | 3 | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C |
| | *Coloburiscus* | 7 | R |
| **PLECOPTERA (STONEFLIES)** | *Zelandobius* | 5 | R |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | VA |
| | *Hydrobiosis* | 5 | C |
| | *Neurochorema* | 6 | C |
| | *Oxyethira* | 2 | C |
| | *Pycnocentria* | 7 | R |
| | *Pycnocentrodes* | 5 | A |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | R |
| | *Maoridiamesa* | 3 | R |
| | Orthocladiinae | 2 | A |
| | Tanytarsini | 3 | A |
| | Empididae | 3 | C |
| | Muscidae | 3 | C |
| | *Austrosimulium* | 3 | C |
| | Tanyderidae | 4 | R |
| | | **No of taxa** | 25 |
| | | **MCI** | 85 |
| | | **SQMCIs** | 4.3 |
| | | **EPT (taxa)** | 8 |
| | | **%EPT (taxa)** | 32 |
| '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 December 2014

| Taxa List | Site Code | | WGA000260 | WGA000450 |
|---|---|---|---|---|
| | Sample Number | | FWB14381 | FWB14382 |
| NEMATODA | Nematoda | 3 | R | - |
| ANNELIDA (WORMS) | Oligochaeta | 1 | A | A |
| | Lumbricidae | 5 | - | R |
| MOLLUSCA | *Potamopyrgus* | 4 | A | A |
| | Sphaeriidae | 3 | - | R |
| CRUSTACEA | Ostracoda | 1 | R | - |
| | *Paracalliope* | 5 | R | R |
| EPHEMEROPTERA (MAYFLIES) | *Austroclima* | 7 | R | R |
| | *Coloburiscus* | 7 | C | - |
| | *Deleatidium* | 8 | A | C |
| | *Nesameletus* | 9 | R | - |
| | *Zephlebia group* | 7 | R | R |
| PLECOPTERA (STONEFLIES) | *Zelandobius* | 5 | C | - |
| COLEOPTERA (BEETLES) | Elmidae | 6 | VA | A |
| MEGALOPTERA (DOBSONFLIES) | *Archichauliodes* | 7 | A | C |
| TRICHOPTERA (CADDISFLIES) | *Hydropsyche (Aoteapsyche)* | 4 | A | VA |
| | *Costachorema* | 7 | C | C |
| | *Hydrobiosis* | 5 | A | C |
| | *Neurochorema* | 6 | C | C |
| | *Beraeoptera* | 8 | R | - |
| | *Oxyethira* | 2 | R | R |
| | *Pycnocentria* | 7 | C | - |
| | *Pycnocentrodes* | 5 | A | C |
| DIPTERA (TRUE FLIES) | *Aphrophila* | 5 | A | A |
| | *Maoridiamesa* | 3 | A | VA |
| | Orthocladiinae | 2 | VA | A |
| | Tanypodinae | 5 | R | - |
| | Tanytarsini | 3 | A | C |
| | Empididae | 3 | R | R |
| | Muscidae | 3 | - | R |
| | *Austrosimulium* | 3 | C | - |
| | Tanyderidae | 4 | - | R |
| ACARINA (MITES) | Acarina | 5 | - | R |
| | | No of taxa | 28 | 24 |
| | | MCI | 99 | 92 |
| | | SQMCIs | 4.4 | 3.8 |
| | | EPT (taxa) | 13 | 8 |
| | | %EPT (taxa) | 46 | 33 |
| '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 20 February 2015

| Taxa List | Site Code | MCI score | WGA000260 | WGA000450 |
|---|---|---|---|---|
| | Sample Number | | FWB15171 | FWB15172 |
| **NEMERTEA** | Nemertea | 3 | - | C |
| **NEMATODA** | Nematoda | 3 | R | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | R | A |
| | Lumbricidae | 5 | - | C |
| **MOLLUSCA** | *Latia* | 5 | - | R |
| | *Physa* | 3 | - | R |
| | *Potamopyrgus* | 4 | A | XA |
| **CRUSTACEA** | *Paracalliope* | 5 | - | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C | C |
| | *Coloburiscus* | 7 | R | - |
| | *Deleatidium* | 8 | C | R |
| **PLECOPTERA (STONEFLIES)** | *Zelandobius* | 5 | R | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | XA | VA |
| | Hydraenidae | 8 | R | - |
| | Ptilodactylidae | 8 | R | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | VA | VA |
| | *Costachorema* | 7 | C | - |
| | *Hydrobiosis* | 5 | A | A |
| | *Neurochorema* | 6 | A | A |
| | *Confluens* | 5 | R | - |
| | *Oxyethira* | 2 | C | - |
| | *Pycnocentria* | 7 | C | R |
| | *Pycnocentrodes* | 5 | C | VA |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | R |
| | *Maoridiamesa* | 3 | A | R |
| | Orthocladiinae | 2 | XA | VA |
| | Tanytarsini | 3 | A | A |
| | Empididae | 3 | A | R |
| | Ephydridae | 4 | R | - |
| | Muscidae | 3 | R | - |
| | *Austrosimulium* | 3 | C | R |
| | Tanyderidae | 4 | R | R |
| | | **No of taxa** | 28 | 24 |
| | | **MCI** | 96 | 89 |
| | | **SQMCIs** | 4.1 | 4.2 |
| | | **EPT (taxa)** | 11 | 7 |
| | | **%EPT (taxa)** | 39 | 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 16 October 2014

| Taxa List | Site Code | MCI score | WKH000100 | WKH000500 | WKH000920 | WKH000950 |
|---|---|---|---|---|---|---|
| | Sample Number | | FWB14294 | FWB14295 | FWB14296 | FWB14298 |
| **NEMATODA** | Nematoda | 3 | - | - | R | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | R | - | A | VA |
| | Lumbricidae | 5 | - | - | - | R |
| **MOLLUSCA** | *Potamopyrgus* | 4 | - | - | C | A |
| **CRUSTACEA** | *Paracalliope* | 5 | - | - | - | R |
| | *Paratya* | 3 | - | - | - | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | - | - | R | - |
| | *Coloburiscus* | 7 | C | VA | R | R |
| | *Deleatidium* | 8 | XA | XA | A | R |
| | *Nesameletus* | 9 | A | C | - | - |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | - | - | - | C |
| | *Austroperla* | 9 | C | - | - | R |
| | *Megaleptoperla* | 9 | A | R | - | - |
| | *Zelandobius* | 5 | - | C | C | C |
| | *Zelandoperla* | 8 | VA | A | - | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | C | C | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | - | C | - | R |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C | A | C | C |
| | *Costachorema* | 7 | C | VA | R | - |
| | *Hydrobiosis* | 5 | R | R | C | R |
| | *Hydrobiosella* | 9 | - | R | - | - |
| | *Hydrochorema* | 9 | R | - | - | - |
| | *Neurochorema* | 6 | - | R | - | - |
| | *Hydropsyche (Orthopsyche)* | 9 | R | - | - | - |
| | *Psilochorema* | 6 | C | - | - | - |
| | *Beraeoptera* | 8 | VA | C | - | - |
| | *Olinga* | 9 | C | - | - | R |
| | *Oxyethira* | 2 | - | - | R | R |
| | *Pycnocentrodes* | 5 | R | C | R | - |
| | *Zelolessica* | 7 | R | - | - | - |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | A | C | C |
| | Eriopterini | 5 | R | R | - | - |
| | *Maoridiamesa* | 3 | C | VA | A | VA |
| | Orthocladiinae | 2 | R | C | A | XA |
| | Tanytarsini | 3 | - | C | R | R |
| | Empididae | 3 | - | R | R | R |
| | Ephydridae | 4 | - | - | - | R |
| | *Austrosimulium* | 3 | - | R | - | R |
| | Tanyderidae | 4 | - | - | R | - |
| | | **No of taxa** | 22 | 22 | 19 | 23 |
| | | **MCI** | 128 | 115 | 88 | 94 |
| | | **SQMCIs** | 7.7 | 7.0 | 3.9 | 2.2 |
| | | **EPT (taxa)** | 16 | 13 | 8 | 8 |
| | | **%EPT (taxa)** | 73 | 59 | 42 | 35 |

| '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 13 February 2015

| Taxa List | Site Code | MCI score | WKH000100 | WKH000500 | WKH000920 | WKH000950 |
|---|---|---|---|---|---|---|
| | Sample Number | | FWB15110 | FWB15111 | FWB15112 | FWB15114 |
| NEMERTEA | Nemertea | 3 | - | - | - | R |
| ANNELIDA (WORMS) | Oligochaeta | 1 | - | R | C | A |
| MOLLUSCA | *Potamopyrgus* | 4 | - | - | A | XA |
| CRUSTACEA | *Paracalliope* | 5 | - | - | - | R |
| EPHEMEROPTERA (MAYFLIES) | *Ameletopsis* | 10 | R | - | - | - |
| | *Coloburiscus* | 7 | R | C | - | - |
| | *Deleatidium* | 8 | XA | VA | - | - |
| | *Nesameletus* | 9 | A | - | - | - |
| PLECOPTERA (STONEFLIES) | *Austroperla* | 9 | C | R | - | - |
| | *Megaleptoperla* | 9 | C | - | - | - |
| | *Zelandoperla* | 8 | XA | R | - | - |
| COLEOPTERA (BEETLES) | Elmidae | 6 | XA | VA | A | C |
| | Hydraenidae | 8 | - | R | R | - |
| MEGALOPTERA (DOBSONFLIES) | *Archichauliodes* | 7 | R | C | R | R |
| TRICHOPTERA (CADDISFLIES) | *Hydropsyche (Aoteapsyche)* | 4 | C | VA | A | A |
| | *Costachorema* | 7 | C | C | - | - |
| | *Hydrobiosis* | 5 | R | C | R | R |
| | *Hydrobiosella* | 9 | R | - | - | - |
| | *Neurochorema* | 6 | R | R | R | - |
| | *Plectrocnemia* | 8 | R | - | - | - |
| | *Psilochorema* | 6 | R | - | - | - |
| | *Beraeoptera* | 8 | A | R | - | - |
| | *Olinga* | 9 | A | - | - | - |
| | *Oxyethira* | 2 | - | - | R | C |
| | *Paroxyethira* | 2 | - | - | R | - |
| | *Pycnocentrodes* | 5 | C | C | - | - |
| DIPTERA (TRUE FLIES) | *Aphrophila* | 5 | A | A | - | R |
| | Eriopterini | 5 | R | R | - | - |
| | *Maoridiamesa* | 3 | R | A | - | - |
| | Orthocladiinae | 2 | - | A | A | VA |
| | *Polypedilum* | 3 | R | - | - | - |
| | Tanytarsini | 3 | - | C | A | A |
| | Empididae | 3 | - | R | R | R |
| | Ephydridae | 4 | R | - | - | - |
| | Muscidae | 3 | R | - | R | C |
| | *Austrosimulium* | 3 | - | - | R | C |
| | Tanyderidae | 4 | - | R | R | - |
| ACARINA (MITES) | Acarina | 5 | - | R | - | - |
| | | No of taxa | 25 | 22 | 16 | 15 |
| | | MCI | 130 | 108 | 79 | 75 |
| | | SQMCIs | 7.3 | 5.6 | 3.7 | 3.6 |
| | | EPT (taxa) | 17 | 10 | 3 | 2 |
| | | %EPT (taxa) | 68 | 45 | 19 | 13 |
| '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 16 October 2014

| Taxa List | Site Code | MCI score | MGE000970 |
|---|---|---|---|
| | Sample Number | | FWB14293 |
| **NEMERTEA** | Nemertea | 3 | R |
| **NEMATODA** | Nematoda | 3 | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | A |
| **MOLLUSCA** | *Latia* | 5 | R |
| | *Potamopyrgus* | 4 | A |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C |
| | *Coloburiscus* | 7 | R |
| | *Deleatidium* | 8 | A |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | R |
| | *Zelandobius* | 5 | VA |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A |
| | Ptilodactylidae | 8 | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A |
| | *Costachorema* | 7 | R |
| | *Hydrobiosis* | 5 | C |
| | *Neurochorema* | 6 | C |
| | *Confluens* | 5 | R |
| | *Oxyethira* | 2 | C |
| | *Pycnocentrodes* | 5 | C |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A |
| | *Maoridiamesa* | 3 | C |
| | Orthocladiinae | 2 | A |
| | Tanytarsini | 3 | A |
| | Empididae | 3 | A |
| | *Austrosimulium* | 3 | A |
| **ACARINA (MITES)** | Acarina | 5 | R |
| | | **No of taxa** | 27 |
| | | **MCI** | 94 |
| | | **SQMCIs** | 4.5 |
| | | **EPT (taxa)** | 11 |
| | | **%EPT (taxa)** | 41 |
| '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 S  tream: summer SEM survey sampled on 13 February 20158

| Taxa List | Site Code / Sample Number | MCI score | MGE000970 / FWB15115 |
|---|---|---|---|
| **NEMERTEA** | Nemertea | 3 | C |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | R |
| **MOLLUSCA** | *Potamopyrgus* | 4 | A |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C |
| | *Coloburiscus* | 7 | R |
| | *Deleatidium* | 8 | R |
| | *Zephlebia group* | 7 | R |
| **PLECOPTERA (STONEFLIES)** | *Zelandobius* | 5 | C |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A |
| | Ptilodactylidae | 8 | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C |
| | *Hydrobiosis* | 5 | R |
| | *Neurochorema* | 6 | R |
| | *Oxyethira* | 2 | A |
| | *Pycnocentrodes* | 5 | C |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | R |
| | Orthocladiinae | 2 | A |
| | Tanytarsini | 3 | R |
| | Empididae | 3 | A |
| | Muscidae | 3 | C |
| | *Austrosimulium* | 3 | A |
| | Tanyderidae | 4 | R |
| | | **No of taxa** | 23 |
| | | **MCI** | 94 |
| | | **SQMCIs** | 4.1 |
| | | **EPT (taxa)** | 9 |
| | | **%EPT (taxa)** | 39 |
| 'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa | |

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

**Table 138** Macroinvertebrate fauna of the Manganui River: spring SEM survey sampled on 8 December 2014

| Taxa List | Site Code | MCI score | MGN000195 | MGN000427 |
|---|---|---|---|---|
| | Sample Number | | FWB14383 | FWB14384 |
| **NEMATODA** | Nematoda | 3 | - | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | A |
| | Lumbricidae | 5 | - | R |
| **MOLLUSCA** | *Potamopyrgus* | 4 | R | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C | R |
| | *Coloburiscus* | 7 | VA | C |
| | *Deleatidium* | 8 | XA | VA |
| | *Nesameletus* | 9 | VA | - |
| **PLECOPTERA (STONEFLIES)** | *Megaleptoperla* | 9 | C | - |
| | *Zelandobius* | 5 | - | R |
| | *Zelandoperla* | 8 | A | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | A |
| | Hydraenidae | 8 | R | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C | VA |
| | *Costachorema* | 7 | - | A |
| | *Hydrobiosis* | 5 | R | C |
| | *Neurochorema* | 6 | - | R |
| | *Plectrocnemia* | 8 | R | R |
| | *Psilochorema* | 6 | C | - |
| | *Beraeoptera* | 8 | VA | - |
| | *Confluens* | 5 | R | - |
| | *Helicopsyche* | 10 | C | - |
| | *Olinga* | 9 | C | - |
| | *Oxyethira* | 2 | - | R |
| | *Pycnocentrodes* | 5 | VA | R |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | C | A |
| | Eriopterini | 5 | C | - |
| | *Maoridiamesa* | 3 | C | VA |
| | Orthocladiinae | 2 | R | A |
| | | **No of taxa** | 23 | 20 |
| | | **MCI** | 129 | 104 |
| | | **SQMCIs** | 7.5 | 4.9 |
| | | **EPT (taxa)** | 15 | 10 |
| | | **%EPT (taxa)** | 65 | 50 |
| 'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa | | |

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

**Table 139** Macroinvertebrate fauna of the Manganui River: summer SEM survey sampled on 20 February 2015

| Taxa List | Site Code | MCI score | MGN000195 | MGN000427 |
|---|---|---|---|---|
| | Sample Number | | FWB15175 | FWB15176 |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | R |
| **MOLLUSCA** | *Potamopyrgus* | 4 | - | A |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | A | C |
| | *Coloburiscus* | 7 | A | R |
| | *Deleatidium* | 8 | XA | C |
| | *Nesameletus* | 9 | VA | - |
| | *Zephlebia group* | 7 | - | R |
| **PLECOPTERA (STONEFLIES)** | *Austroperla* | 9 | C | - |
| | *Megaleptoperla* | 9 | C | - |
| | *Zelandoperla* | 8 | C | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | VA |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A | VA |
| | *Costachorema* | 7 | R | R |
| | *Hydrobiosis* | 5 | C | A |
| | *Neurochorema* | 6 | - | C |
| | *Psilochorema* | 6 | R | - |
| | *Beraeoptera* | 8 | A | - |
| | *Olinga* | 9 | C | - |
| | *Pycnocentrodes* | 5 | A | R |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | C |
| | Eriopterini | 5 | R | - |
| | *Maoridiamesa* | 3 | - | R |
| | Orthocladiinae | 2 | R | XA |
| | *Polypedilum* | 3 | R | - |
| | Tanypodinae | 5 | - | R |
| | Tanytarsini | 3 | - | A |
| | Empididae | 3 | R | R |
| | Muscidae | 3 | - | C |
| | *Austrosimulium* | 3 | R | R |
| | | **No of taxa** | 22 | 21 |
| | | **MCI** | 123 | 96 |
| | | **SQMCIs** | 7.6 | 3.1 |
| | | **EPT (taxa)** | 14 | 9 |
| | | **%EPT (taxa)** | 64 | 43 |
| '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 December 2014

| Taxa List | Site Code / Sample Number | MCI score | MKW000200 / FWB14385 | MKW000300 / FWB14386 |
|---|---|---|---|---|
| **EPHEMEROPTERA (MAYFLIES)** | *Ameletopsis* | 10 | R | - |
| | *Austroclima* | 7 | R | R |
| | *Coloburiscus* | 7 | A | VA |
| | *Deleatidium* | 8 | XA | XA |
| | *Nesameletus* | 9 | A | R |
| | *Zephlebia group* | 7 | R | R |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | R | - |
| | *Austroperla* | 9 | R | - |
| | *Megaleptoperla* | 9 | A | - |
| | *Zelandobius* | 5 | R | - |
| | *Zelandoperla* | 8 | A | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | A |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C | A |
| | *Costachorema* | 7 | C | A |
| | *Hydrobiosis* | 5 | R | R |
| | *Hydrobiosella* | 9 | R | - |
| | *Hydrochorema* | 9 | R | - |
| | *Plectrocnemia* | 8 | C | - |
| | *Psilochorema* | 6 | R | R |
| | *Beraeoptera* | 8 | VA | C |
| | *Confluens* | 5 | - | R |
| | *Helicopsyche* | 10 | C | - |
| | *Olinga* | 9 | C | R |
| | *Pycnocentrodes* | 5 | A | A |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | A |
| | Eriopterini | 5 | R | - |
| | *Maoridiamesa* | 3 | A | A |
| | Orthocladiinae | 2 | R | C |
| | *Polypedilum* | 3 | C | - |
| | Tanypodinae | 5 | - | R |
| | Tanytarsini | 3 | R | C |
| | Empididae | 3 | R | - |
| | | **No of taxa** | 31 | 20 |
| | | **MCI** | 130 | 118 |
| | | **SQMCIs** | 7.5 | 7.3 |
| | | **EPT (taxa)** | 22 | 13 |
| | | **%EPT (taxa)** | 71 | 65 |
| '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 20 February 2015

| Taxa List | Site Code | MCI score | MKW000200 | MKW000300 |
|---|---|---|---|---|
| | Sample Number | | FWB15173 | FWB15174 |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | R | C |
| | *Coloburiscus* | 7 | A | C |
| | *Deleatidium* | 8 | XA | A |
| | *Nesameletus* | 9 | VA | C |
| **PLECOPTERA (STONEFLIES)** | *Austroperla* | 9 | R | - |
| | *Megaleptoperla* | 9 | A | - |
| | *Zelandoperla* | 8 | A | R |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | XA | A |
| | Hydraenidae | 8 | R | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A | A |
| | *Costachorema* | 7 | C | C |
| | *Hydrobiosis* | 5 | C | C |
| | *Neurochorema* | 6 | R | C |
| | *Plectrocnemia* | 8 | R | - |
| | *Psilochorema* | 6 | R | - |
| | *Beraeoptera* | 8 | C | R |
| | *Olinga* | 9 | C | - |
| | *Oxyethira* | 2 | - | R |
| | *Pycnocentrodes* | 5 | R | C |
| | *Zelolessica* | 7 | R | - |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | A |
| | Eriopterini | 5 | R | - |
| | *Maoridiamesa* | 3 | C | A |
| | Orthocladiinae | 2 | A | A |
| | *Polypedilum* | 3 | R | - |
| | Tanytarsini | 3 | - | A |
| | Empididae | 3 | - | R |
| | Muscidae | 3 | R | R |
| | *Austrosimulium* | 3 | - | R |
| | | **No of taxa** | 26 | 22 |
| | | **MCI** | 126 | 108 |
| | | **SQMCIs** | 7.0 | 4.9 |
| | | **EPT (taxa)** | 17 | 11 |
| | | **%EPT (taxa)** | 65 | 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 2 December 2014

| Taxa List | Site Code | MCI score | WTR000850 |
|---|---|---|---|
| | Sample Number | | FWB14371 |
| **NEMERTEA** | Nemertea | 3 | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | A |
| **CRUSTACEA** | *Paratya* | 3 | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Deleatidium* | 8 | A |
| | *Zephlebia group* | 7 | C |
| **PLECOPTERA (STONEFLIES)** | *Zelandobius* | 5 | C |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | VA |
| | *Costachorema* | 7 | R |
| | *Hydrobiosis* | 5 | C |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | C |
| | *Maoridiamesa* | 3 | A |
| | Orthocladiinae | 2 | VA |
| | Tanytarsini | 3 | A |
| | *Austrosimulium* | 3 | R |
| | Tanyderidae | 4 | R |
| | | **No of taxa** | 17 |
| | | **MCI** | 89 |
| | | **SQMCIs** | 3.4 |
| | | **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

**Table 143** Macroinvertebrate fauna of the Waitara River: summer SEM survey sampled on 20 February 2015

| Taxa List | Site Code | MCI score | WTR000850 |
|---|---|---|---|
| | Sample Number | | FWB15170 |
| ANNELIDA (WORMS) | Oligochaeta | 1 | R |
| MOLLUSCA | *Potamopyrgus* | 4 | A |
| EPHEMEROPTERA (MAYFLIES) | *Austroclima* | 7 | R |
| | *Zephlebia group* | 7 | C |
| COLEOPTERA (BEETLES) | Elmidae | 6 | R |
| MEGALOPTERA (DOBSONFLIES) | *Archichauliodes* | 7 | R |
| TRICHOPTERA (CADDISFLIES) | *Hydropsyche (Aoteapsyche)* | 4 | VA |
| | *Costachorema* | 7 | R |
| | *Hydrobiosis* | 5 | R |
| | *Oxyethira* | 2 | A |
| | *Pycnocentrodes* | 5 | R |
| DIPTERA (TRUE FLIES) | Orthocladiinae | 2 | XA |
| | Tanytarsini | 3 | A |
| | Empididae | 3 | R |
| | *Austrosimulium* | 3 | C |
| | Tanyderidae | 4 | R |
| | | No of taxa | 16 |
| | | MCI | 88 |
| | | SQMCIs | 2.5 |
| | | EPT (taxa) | 6 |
| | | %EPT (taxa) | 38 |
| '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 2 December 2014

| Taxa List | Site Code | MCI score | MGT000488 | MGT000520 |
|---|---|---|---|---|
| | Sample Number | | FWB14363 | FWB14369 |
| **NEMERTEA** | Nemertea | 3 | R | - |
| **NEMATODA** | Nematoda | 3 | - | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | C | XA |
| | Lumbricidae | 5 | R | - |
| **MOLLUSCA** | *Potamopyrgus* | 4 | A | XA |
| **CRUSTACEA** | *Paracalliope* | 5 | VA | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C | R |
| **COLEOPTERA (BEETLES)** | Dytiscidae | 5 | R | - |
| **TRICHOPTERA (CADDISFLIES)** | *Hydrobiosis* | 5 | - | C |
| | *Oxyethira* | 2 | - | R |
| | *Triplectides* | 5 | - | R |
| **DIPTERA (TRUE FLIES)** | *Zelandotipula* | 6 | R | - |
| | *Chironomus* | 1 | - | R |
| | Orthocladiinae | 2 | C | A |
| | *Polypedilum* | 3 | R | - |
| | Empididae | 3 | R | A |
| | *Austrosimulium* | 3 | C | - |
| | Tanyderidae | 4 | - | R |
| | | **No of taxa** | 12 | 11 |
| | | **MCI** | 78 | 67 |
| | | **SQMCIs** | 4.6 | 2.5 |
| | | **EPT (taxa)** | 1 | 3 |
| | | **%EPT (taxa)** | 8 | 27 |
| '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 12 December 2015

| Taxa List | Site Code | MCI score | MGT000488 | MGT000520 |
|---|---|---|---|---|
| | Sample Number | | FWB15095 | FWB15101 |
| **NEMERTEA** | Nemertea | 3 | R | R |
| **NEMATODA** | Nematoda | 3 | R | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | VA | VA |
| **MOLLUSCA** | *Physa* | 3 | - | R |
| | *Potamopyrgus* | 4 | A | XA |
| | Sphaeriidae | 3 | - | R |
| **CRUSTACEA** | Ostracoda | 1 | C | C |
| | Isopoda | 5 | C | - |
| | *Paracalliope* | 5 | XA | R |
| | *Paratya* | 3 | C | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | - | R |
| **ODONATA (DRAGONFLIES)** | *Xanthocnemis* | 4 | R | - |
| **TRICHOPTERA (CADDISFLIES)** | *Hydrobiosis* | 5 | - | R |
| | *Plectrocnemia* | 8 | R | - |
| | *Oxyethira* | 2 | R | C |
| | *Triplectides* | 5 | - | A |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | - | R |
| | Eriopterini | 5 | R | - |
| | Orthocladiinae | 2 | C | R |
| | *Polypedilum* | 3 | R | - |
| | *Paradixa* | 4 | R | - |
| | Empididae | 3 | - | R |
| | *Austrosimulium* | 3 | - | R |
| | Tanyderidae | 4 | - | R |
| **ACARINA (MITES)** | Acarina | 5 | C | R |
| | | **No of taxa** | 16 | 17 |
| | | **MCI** | 73 | 72 |
| | | **SQMCIs** | 4.3 | 3.5 |
| | | **EPT (taxa)** | 1 | 3 |
| | | **%EPT (taxa)** | 6 | 18 |
| '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 7 January 2015

| Taxa List | Site Code | MCI score | WMK000100 | WMK000298 |
|---|---|---|---|---|
| | Sample Number | | FWB15005 | FWB15006 |
| ANNELIDA (WORMS) | Oligochaeta | 1 | R | A |
| MOLLUSCA | *Potamopyrgus* | 4 | R | XA |
| CRUSTACEA | Paraleptamphopidae | 5 | R | - |
| | Talitridae | 5 | R | - |
| EPHEMEROPTERA (MAYFLIES) | *Austroclima* | 7 | A | R |
| | *Coloburiscus* | 7 | VA | - |
| | *Deleatidium* | 8 | VA | C |
| | *Ichthybotus* | 8 | R | - |
| | *Nesameletus* | 9 | R | - |
| | *Zephlebia group* | 7 | A | R |
| PLECOPTERA (STONEFLIES) | *Austroperla* | 9 | A | - |
| | *Megaleptoperla* | 9 | R | - |
| | *Stenoperla* | 10 | C | - |
| | *Zelandobius* | 5 | R | - |
| | *Zelandoperla* | 8 | R | - |
| COLEOPTERA (BEETLES) | Elmidae | 6 | C | C |
| | Hydraenidae | 8 | R | - |
| | Ptilodactylidae | 8 | R | - |
| MEGALOPTERA (DOBSONFLIES) | *Archichauliodes* | 7 | C | - |
| TRICHOPTERA (CADDISFLIES) | *Costachorema* | 7 | R | R |
| | *Hydrobiosis* | 5 | - | A |
| | *Hydrobiosella* | 9 | C | - |
| | *Neurochorema* | 6 | - | R |
| | *Hydropsyche (Orthopsyche)* | 9 | VA | R |
| | *Psilochorema* | 6 | R | R |
| | *Oxyethira* | 2 | R | R |
| | *Pycnocentria* | 7 | R | - |
| | *Pycnocentrodes* | 5 | - | R |
| | *Triplectides* | 5 | - | R |
| DIPTERA (TRUE FLIES) | *Aphrophila* | 5 | - | R |
| | Hexatomini | 5 | R | - |
| | *Maoridiamesa* | 3 | - | A |
| | Orthocladiinae | 2 | R | A |
| | *Polypedilum* | 3 | VA | C |
| | *Nothodixa* | 4 | R | - |
| | Empididae | 3 | - | C |
| | Muscidae | 3 | - | R |
| | Psychodidae | 1 | - | R |
| | *Austrosimulium* | 3 | - | R |
| | Tanyderidae | 4 | - | C |
| ACARINA (MITES) | Acarina | 5 | R | - |
| | | No of taxa | 30 | 23 |
| | | MCI | 127 | 91 |
| | | SQMCIs | 6.9 | 3.9 |
| | | EPT (taxa) | 16 | 10 |
| | | %EPT (taxa) | 53 | 43 |
| '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 24 March 2015

| Taxa List | Site Code | MCI score | WMK000100 | WMK000298 |
|---|---|---|---|---|
| | Sample Number | | FWB15211 | FWB15212 |
| **PLATYHELMINTHES (FLATWORMS)** | *Neppia* | 6 | R | - |
| **NEMERTEA** | Nemertea | 3 | - | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | R | A |
| **MOLLUSCA** | *Potamopyrgus* | 4 | R | VA |
| | Sphaeriidae | 3 | - | R |
| **CRUSTACEA** | Isopoda | 5 | R | - |
| | Talitridae | 5 | C | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Ameletopsis* | 10 | C | - |
| | *Austroclima* | 7 | R | C |
| | *Coloburiscus* | 7 | A | R |
| | *Deleatidium* | 8 | C | - |
| | *Ichthybotus* | 8 | R | - |
| | *Nesameletus* | 9 | R | - |
| | *Zephlebia group* | 7 | VA | C |
| **PLECOPTERA (STONEFLIES)** | *Austroperla* | 9 | A | - |
| | *Megaleptoperla* | 9 | R | - |
| | *Stenoperla* | 10 | R | - |
| | *Zelandobius* | 5 | R | - |
| | *Zelandoperla* | 8 | R | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | C | C |
| | Hydraenidae | 8 | R | - |
| | Ptilodactylidae | 8 | C | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | C |
| **TRICHOPTERA (CADDISFLIES)** | *Costachorema* | 7 | R | - |
| | *Hydrobiosella* | 9 | C | - |
| | *Hydropsyche (Orthopsyche)* | 9 | VA | - |
| | *Psilochorema* | 6 | R | R |
| | *Oxyethira* | 2 | - | R |
| | *Pycnocentria* | 7 | R | - |
| | *Pycnocentrodes* | 5 | - | R |
| | *Triplectides* | 5 | R | R |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | - | R |
| | Hexatomini | 5 | R | R |
| | Orthocladiinae | 2 | R | A |
| | *Polypedilum* | 3 | A | C |
| | Empididae | 3 | R | - |
| | *Austrosimulium* | 3 | - | R |
| | Tanyderidae | 4 | - | R |
| | | **No of taxa** | 31 | 20 |
| | | **MCI** | 131 | 93 |
| | | **SQMCIs** | 7.5 | 3.8 |
| | | **EPT (taxa)** | 18 | 6 |
| | | **%EPT (taxa)** | 58 | 30 |
| '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 23 October 2014

| Taxa List | Site Code | MCI score | WAI000110 |
|---|---|---|---|
| | Sample Number | | FWB14333 |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | VA |
| | Lumbricidae | 5 | R |
| **MOLLUSCA** | *Latia* | 5 | C |
| | *Potamopyrgus* | 4 | VA |
| **CRUSTACEA** | *Paracalliope* | 5 | C |
| | *Paranephrops* | 5 | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | VA |
| | *Coloburiscus* | 7 | R |
| | *Zephlebia group* | 7 | R |
| **PLECOPTERA (STONEFLIES)** | *Zelandobius* | 5 | C |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | VA |
| | *Hydrobiosis* | 5 | A |
| | *Neurochorema* | 6 | R |
| | *Pycnocentria* | 7 | VA |
| | *Pycnocentrodes* | 5 | VA |
| | *Triplectides* | 5 | R |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A |
| | Orthocladiinae | 2 | R |
| | *Polypedilum* | 3 | R |
| | *Austrosimulium* | 3 | C |
| | | **No of taxa** | 22 |
| | | **MCI** | 99 |
| | | **SQMCIs** | 4.9 |
| | | **EPT (taxa)** | 10 |
| | | **%EPT (taxa)** | 45 |
| '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 11 February 2015

| Taxa List | Site Code | MCI score | WAI000110 |
|---|---|---|---|
| | Sample Number | | FWB15081 |
| PLATYHELMINTHES (FLATWORMS) | *Cura* | 3 | R |
| ANNELIDA (WORMS) | Oligochaeta | 1 | A |
| MOLLUSCA | *Latia* | 5 | A |
| | *Potamopyrgus* | 4 | VA |
| CRUSTACEA | *Paracalliope* | 5 | C |
| EPHEMEROPTERA (MAYFLIES) | *Austroclima* | 7 | VA |
| PLECOPTERA (STONEFLIES) | *Zelandobius* | 5 | R |
| COLEOPTERA (BEETLES) | Elmidae | 6 | VA |
| MEGALOPTERA (DOBSONFLIES) | *Archichauliodes* | 7 | C |
| TRICHOPTERA (CADDISFLIES) | *Hydropsyche (Aoteapsyche)* | 4 | VA |
| | *Hydrobiosis* | 5 | C |
| | *Neurochorema* | 6 | R |
| | *Hudsonema* | 6 | R |
| | *Oxyethira* | 2 | R |
| | *Pycnocentrodes* | 5 | A |
| DIPTERA (TRUE FLIES) | *Aphrophila* | 5 | R |
| | Orthocladiinae | 2 | R |
| | *Polypedilum* | 3 | R |
| | *Austrosimulium* | 3 | A |
| | | No of taxa | 19 |
| | | MCI | 88 |
| | | SQMCIs | 5.0 |
| | | EPT (taxa) | 7 |
| | | %EPT (taxa) | 37 |
| '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 13 October 2014

| Taxa List | Site Code | MCI score | PNH000200 | PNH000900 |
|---|---|---|---|---|
| | Sample Number | | FWB14254 | FWB14255 |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | R |
| **MOLLUSCA** | *Potamopyrgus* | 4 | - | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | R | A |
| | *Coloburiscus* | 7 | VA | VA |
| | *Deleatidium* | 8 | XA | XA |
| | *Nesameletus* | 9 | VA | C |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | - | R |
| | *Megaleptoperla* | 9 | R | - |
| | *Stenoperla* | 10 | R | - |
| | *Zelandobius* | 5 | R | A |
| | *Zelandoperla* | 8 | VA | R |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | C |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C | A |
| | *Costachorema* | 7 | C | - |
| | *Hydrobiosis* | 5 | - | R |
| | *Psilochorema* | 6 | R | - |
| | *Beraeoptera* | 8 | C | A |
| | *Olinga* | 9 | R | R |
| | *Pycnocentrodes* | 5 | R | VA |
| | *Triplectides* | 5 | R | - |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | R | R |
| | Eriopterini | 5 | R | - |
| | *Zelandotipula* | 6 | - | R |
| | *Maoridiamesa* | 3 | - | R |
| | Orthocladiinae | 2 | - | R |
| | Tabanidae | 3 | R | - |
| | | **No of taxa** | 20 | 20 |
| | | **MCI** | 133 | 114 |
| | | **SQMCIs** | 7.9 | 7.2 |
| | | **EPT (taxa)** | 15 | 12 |
| | | **%EPT (taxa)** | 75 | 60 |
| 'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa | | |

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

**Table 151** Macroinvertebrate fauna of the Punehu Stream: summer SEM survey sampled on 4 February 2015

| Taxa List | Site Code | MCI score | PNH000200 | PNH000900 |
|---|---|---|---|---|
| | Sample Number | | FWB15059 | FWB15060 |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | R |
| **MOLLUSCA** | *Potamopyrgus* | 4 | - | R |
| **CRUSTACEA** | Talitridae | 5 | - | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | A | A |
| | *Coloburiscus* | 7 | A | A |
| | *Deleatidium* | 8 | XA | XA |
| | *Nesameletus* | 9 | XA | R |
| **PLECOPTERA (STONEFLIES)** | *Austroperla* | 9 | R | - |
| | *Megaleptoperla* | 9 | C | - |
| | *Stenoperla* | 10 | R | - |
| | *Zelandoperla* | 8 | C | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | - |
| | Hydraenidae | 8 | C | R |
| | Hydrophilidae | 5 | - | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A | VA |
| | *Costachorema* | 7 | C | - |
| | *Hydrobiosis* | 5 | A | C |
| | *Neurochorema* | 6 | R | - |
| | *Psilochorema* | 6 | C | - |
| | *Beraeoptera* | 8 | R | R |
| | *Olinga* | 9 | C | - |
| | *Pycnocentrodes* | 5 | C | A |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | C | R |
| | Eriopterini | 5 | R | - |
| | *Maoridiamesa* | 3 | A | C |
| | Orthocladiinae | 2 | A | C |
| | *Polypedilum* | 3 | - | VA |
| | Tanytarsini | 3 | R | C |
| | Empididae | 3 | - | R |
| | Muscidae | 3 | R | - |
| | *Austrosimulium* | 3 | - | A |
| | Tanyderidae | 4 | - | C |
| **ACARINA (MITES)** | Acarina | 5 | R | - |
| | | **No of taxa** | 26 | 22 |
| | | **MCI** | 126 | 99 |
| | | **SQMCIs** | 7.9 | 6.5 |
| | | **EPT (taxa)** | 16 | 8 |
| | | **%EPT (taxa)** | 62 | 36 |
| '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 25 November 2014

| Taxa List | Site Code | MCI score | PAT000200 | PAT000315 | PAT000360 |
|---|---|---|---|---|---|
| | Sample Number | | FWB14355 | FWB14356 | FWB14359 |
| **NEMATODA** | Nematoda | 3 | - | - | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | R | A |
| **MOLLUSCA** | Sphaeriidae | 3 | - | - | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | R | C | R |
| | *Coloburiscus* | 7 | VA | XA | VA |
| | *Deleatidium* | 8 | XA | XA | XA |
| | *Neozephlebia* | 7 | R | - | - |
| | *Nesameletus* | 9 | - | R | - |
| | *Zephlebia group* | 7 | - | R | R |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | R | - | R |
| | *Austroperla* | 9 | C | - | - |
| | *Megaleptoperla* | 9 | C | R | - |
| | *Stenoperla* | 10 | R | - | - |
| | *Zelandobius* | 5 | A | R | R |
| | *Zelandoperla* | 8 | A | R | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | C | C | VA |
| | Hydraenidae | 8 | R | C | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | - | C | VA |
| | *Costachorema* | 7 | - | A | A |
| | *Hydrobiosis* | 5 | - | R | C |
| | *Hydrobiosella* | 9 | C | - | - |
| | *Neurochorema* | 6 | - | - | R |
| | *Hydropsyche (Orthopsyche)* | 9 | C | - | R |
| | *Beraeoptera* | 8 | A | C | - |
| | *Helicopsyche* | 10 | R | - | - |
| | *Olinga* | 9 | C | R | R |
| | *Oxyethira* | 2 | - | - | R |
| | *Pycnocentrodes* | 5 | - | C | C |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | A | VA |
| | Eriopterini | 5 | R | - | - |
| | *Maoridiamesa* | 3 | R | C | VA |
| | Orthocladiinae | 2 | C | A | VA |
| | *Polypedilum* | 3 | R | - | - |
| | Tanypodinae | 5 | - | - | R |
| | Tanytarsini | 3 | - | - | A |
| | Empididae | 3 | - | - | C |
| | Muscidae | 3 | - | - | R |
| | *Austrosimulium* | 3 | - | - | C |
| | | **No of taxa** | 23 | 21 | 28 |
| | | **MCI** | 138 | 124 | 101 |
| | | **SQMCIs** | 7.7 | 7.3 | 5.9 |
| | | **EPT (taxa)** | 15 | 14 | 13 |
| | | **%EPT (taxa)** | 65 | 67 | 46 |
| '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 10 February 2015

| Taxa List | Site Code | MCI score | PAT000200 | PAT000315 | PAT000360 |
|---|---|---|---|---|---|
| | Sample Number | | FWB15061 | FWB15062 | FWB15067 |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | R | VA |
| **MOLLUSCA** | *Potamopyrgus* | 4 | - | C | C |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | A | C | C |
| | *Coloburiscus* | 7 | VA | XA | A |
| | *Deleatidium* | 8 | XA | XA | A |
| | *Nesameletus* | 9 | C | A | - |
| | *Zephlebia group* | 7 | R | C | C |
| **PLECOPTERA (STONEFLIES)** | *Austroperla* | 9 | C | - | - |
| | *Megaleptoperla* | 9 | C | R | - |
| | *Stenoperla* | 10 | C | - | - |
| | *Taraperla* | 10 | R | - | - |
| | *Zelandobius* | 5 | R | - | - |
| | *Zelandoperla* | 8 | A | C | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | VA | A |
| | Hydraenidae | 8 | C | A | R |
| | Hydrophilidae | 5 | R | - | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R | VA | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | R | XA | VA |
| | *Costachorema* | 7 | R | C | R |
| | *Hydrobiosis* | 5 | R | C | A |
| | *Hydrobiosella* | 9 | R | - | - |
| | *Neurochorema* | 6 | - | C | C |
| | *Hydropsyche (Orthopsyche)* | 9 | C | - | - |
| | *Psilochorema* | 6 | R | - | - |
| | *Beraeoptera* | 8 | R | R | - |
| | *Confluens* | 5 | R | - | R |
| | *Helicopsyche* | 10 | R | - | - |
| | Oeconesidae | 5 | - | R | - |
| | *Olinga* | 9 | C | - | - |
| | *Pycnocentria* | 7 | R | - | - |
| | *Pycnocentrodes* | 5 | - | C | C |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | VA | A |
| | Eriopterini | 5 | - | R | - |
| | *Harrisius* | 6 | - | R | - |
| | *Maoridiamesa* | 3 | - | C | VA |
| | Orthocladiinae | 2 | C | A | VA |
| | *Polypedilum* | 3 | A | - | - |
| | Tanypodinae | 5 | - | C | R |
| | Tanytarsini | 3 | - | C | VA |
| | Empididae | 3 | - | R | R |
| | Muscidae | 3 | - | - | C |
| | *Austrosimulium* | 3 | R | C | - |
| | Tanyderidae | 4 | - | R | - |
| **ACARINA (MITES)** | Acarina | 5 | - | - | R |
| | | **No of taxa** | 30 | 29 | 23 |
| | | **MCI** | 138 | 110 | 101 |
| | | **SQMCIs** | 7.6 | 6.2 | 3.4 |
| | | **EPT (taxa)** | 22 | 14 | 10 |
| | | **%EPT (taxa)** | 73 | 48 | 43 |
| 'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa | | | |

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

**Table 154** Macroinvertebrate fauna of the Mangaehu River: spring SEM survey sampled on 25 November 2014

| Taxa List | Site Code | MCI score | MGH000950 |
|---|---|---|---|
| | Sample Number | | FWB14362 |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | R |
| **MOLLUSCA** | *Potamopyrgus* | 4 | C |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | VA |
| | *Coloburiscus* | 7 | C |
| | *Deleatidium* | 8 | A |
| | *Zephlebia group* | 7 | C |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | R |
| | *Zelandobius* | 5 | R |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A |
| | *Costachorema* | 7 | A |
| | *Hydrobiosis* | 5 | A |
| | *Hydropsyche (Orthopsyche)* | 9 | R |
| | *Pycnocentria* | 7 | C |
| | *Pycnocentrodes* | 5 | VA |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A |
| | *Maoridiamesa* | 3 | VA |
| | Orthocladiinae | 2 | A |
| | *Polypedilum* | 3 | R |
| | Tanytarsini | 3 | A |
| | *Austrosimulium* | 3 | C |
| | | **No of taxa** | 22 |
| | | **MCI** | 103 |
| | | **SQMCIs** | 5.0 |
| | | **EPT (taxa)** | 12 |
| | | **%EPT (taxa)** | 55 |
| 'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa | |

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

**Table 155** Macroinvertebrate fauna of the Mangaehu River: summer SEM survey sampled on 10 February 2015

| Taxa List | Site Code | MCI score | MGH000950 |
|---|---|---|---|
| | Sample Number | | FWB15070 |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | R |
| **MOLLUSCA** | *Ferrissia* | 3 | R |
| | *Potamopyrgus* | 4 | C |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | VA |
| | *Coloburiscus* | 7 | A |
| | *Deleatidium* | 8 | C |
| | *Rallidens* | 9 | R |
| | *Zephlebia group* | 7 | C |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | C |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | VA |
| | *Hydrobiosis* | 5 | A |
| | *Neurochorema* | 6 | R |
| | *Pycnocentria* | 7 | C |
| | *Pycnocentrodes* | 5 | A |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A |
| | *Maoridiamesa* | 3 | A |
| | Orthocladiinae | 2 | A |
| | Tanytarsini | 3 | A |
| | Empididae | 3 | C |
| | Muscidae | 3 | C |
| | *Austrosimulium* | 3 | R |
| | | **No of taxa** | 22 |
| | | **MCI** | 98 |
| | | **SQMCIs** | 5.1 |
| | | **EPT (taxa)** | 10 |
| | | **%EPT (taxa)** | 45 |
| '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 15 October 2014

| Taxa List | Site Code | MCI score | WGG000115 | WGG000150 | WGG000500 | WGG000665 | WGG000895 | WGG000995 |
|---|---|---|---|---|---|---|---|---|
| | Sample Number | | FWB14278 | FWB14279 | FWB14280 | FWB14283 | FWB14284 | FWB14285 |
| **PLATYHELMINTHES (FLATWORMS)** | *Neppia* | 6 | R | - | - | - | - | - |
| **NEMATODA** | Nematoda | 3 | - | - | R | - | C | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | R | R | C | - | VA | A |
| | Lumbricidae | 5 | - | - | - | - | R | C |
| **MOLLUSCA** | *Latia* | 5 | - | - | - | - | R | - |
| | *Potamopyrgus* | 4 | - | - | R | R | A | A |
| **CRUSTACEA** | *Paracalliope* | 5 | - | - | - | - | - | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C | A | C | - | R | - |
| | *Coloburiscus* | 7 | VA | XA | VA | A | R | R |
| | *Deleatidium* | 8 | VA | XA | XA | XA | A | A |
| | *Neozephlebia* | 7 | - | R | - | - | - | - |
| | *Nesameletus* | 9 | A | A | - | - | - | - |
| | *Zephlebia group* | 7 | - | R | - | - | - | R |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | R | C | - | - | - | - |
| | *Austroperla* | 9 | C | - | - | - | - | - |
| | *Megaleptoperla* | 9 | C | C | - | - | - | - |
| | *Stenoperla* | 10 | C | - | - | - | - | - |
| | *Zelandobius* | 5 | C | R | A | C | A | A |
| | *Zelandoperla* | 8 | VA | VA | - | - | - | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | A | A | C | C | R |
| | Hydraenidae | 8 | R | A | R | - | - | - |
| | Ptilodactylidae | 8 | - | - | - | - | R | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | A | A | C | R | R |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A | A | VA | C | C | A |
| | *Costachorema* | 7 | - | - | R | R | R | R |
| | *Hydrobiosis* | 5 | - | R | R | C | R | R |
| | *Hydrobiosella* | 9 | - | R | - | - | - | - |
| | *Neurochorema* | 6 | - | - | R | - | - | R |
| | *Hydropsyche (Orthopsyche)* | 9 | - | R | - | - | - | - |
| | *Psilochorema* | 6 | R | - | - | - | - | - |
| | *Beraeoptera* | 8 | A | VA | C | R | - | - |
| | *Confluens* | 5 | R | R | R | - | - | - |
| | *Helicopsyche* | 10 | A | C | - | - | - | - |
| | Oeconesidae | 5 | - | R | - | - | - | - |
| | *Olinga* | 9 | C | C | - | - | - | - |
| | *Pycnocentria* | 7 | R | - | - | - | C | C |
| | *Pycnocentrodes* | 5 | C | C | A | A | VA | XA |
| | *Zelolessica* | 7 | C | - | - | - | - | - |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | A | C | - | - | R |
| | Eriopterini | 5 | R | C | R | - | - | - |
| | *Maoridiamesa* | 3 | R | - | R | R | A | A |
| | Orthocladiinae | 2 | R | - | A | C | A | A |
| | *Polypedilum* | 3 | - | R | - | - | - | R |
| | Tanytarsini | 3 | R | - | R | C | - | R |
| | Empididae | 3 | C | R | - | - | - | - |
| | *Austrosimulium* | 3 | - | - | - | - | R | C |
| | | **No of taxa** | 30 | 28 | 22 | 14 | 20 | 22 |
| | | **MCI** | 125 | 128 | 104 | 106 | 102 | 98 |
| | | **SQMCIs** | 7.4 | 7.5 | 6.9 | 7.6 | 3.6 | 4.8 |
| | | **EPT (taxa)** | 19 | 20 | 11 | 8 | 9 | 10 |
| | | **%EPT (taxa)** | 63 | 71 | 50 | 57 | 45 | 45 |
| '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 25 February 2014

| Taxa List | Site Code | MCI score | WGG000115 | WGG000150 | WGG000500 | WGG000665 | WGG000895 | WGG000995 |
|---|---|---|---|---|---|---|---|---|
| | Sample Number | | FWB15083 | FWB15084 | FWB15085 | FWB15090 | FWB15091 | FWB15092 |
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | - | - | - | - | R | R |
| | *Neppia* | 6 | R | - | - | - | - | - |
| **NEMERTEA** | Nemertea | 3 | - | - | - | - | C | R |
| **NEMATODA** | Nematoda | 3 | - | - | - | R | - | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | R | R | C | A | C |
| | Lumbricidae | 5 | - | - | - | - | R | R |
| **MOLLUSCA** | *Latia* | 5 | - | - | - | - | R | R |
| | *Potamopyrgus* | 4 | - | - | R | R | VA | VA |
| **CRUSTACEA** | *Paracalliope* | 5 | - | - | - | - | R | R |
| | *Paranephrops* | 5 | - | - | - | - | R | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Ameletopsis* | 10 | R | - | - | - | - | - |
| | *Austroclima* | 7 | A | VA | C | A | C | R |
| | *Coloburiscus* | 7 | XA | XA | A | A | R | - |
| | *Deleatidium* | 8 | XA | XA | XA | VA | R | R |
| | *Nesameletus* | 9 | A | VA | R | - | - | - |
| | *Zephlebia group* | 7 | - | - | - | - | R | R |
| **PLECOPTERA (STONEFLIES)** | *Austroperla* | 9 | C | R | - | - | - | - |
| | *Megaleptoperla* | 9 | A | C | - | - | - | - |
| | *Stenoperla* | 10 | R | - | - | - | - | - |
| | *Taraperla* | 10 | C | - | - | - | - | - |
| | *Zelandoperla* | 8 | VA | R | - | - | - | - |
| **HEMIPTERA (BUGS)** | *Saldula* | 5 | - | - | - | - | - | R |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | A | VA | C | R | C |
| | Hydraenidae | 8 | A | A | C | - | - | - |
| | Hydrophilidae | 5 | R | - | - | - | - | - |
| | Ptilodactylidae | 8 | - | C | - | - | - | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | A | VA | A | C | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C | VA | XA | XA | VA | XA |
| | *Costachorema* | 7 | R | R | R | C | - | - |
| | *Hydrobiosis* | 5 | C | C | A | A | C | C |
| | *Neurochorema* | 6 | - | - | R | C | R | - |
| | *Beraeoptera* | 8 | C | C | - | - | - | - |
| | *Helicopsyche* | 10 | R | R | - | - | - | - |
| | *Olinga* | 9 | A | R | - | - | - | - |
| | *Pycnocentria* | 7 | C | - | - | - | - | - |
| | *Pycnocentrodes* | 5 | - | R | C | C | VA | VA |
| | *Zelolessica* | 7 | C | - | - | - | - | - |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | VA | VA | C | A | R | - |
| | Eriopterini | 5 | R | R | R | R | - | - |
| | *Harrisius* | 6 | - | - | - | - | R | - |
| | *Maoridiamesa* | 3 | - | - | R | VA | R | - |
| | Orthocladiinae | 2 | C | R | C | VA | C | VA |
| | *Polypedilum* | 3 | C | A | R | - | C | - |
| | Tanytarsini | 3 | - | - | C | A | C | C |
| | Empididae | 3 | - | - | - | R | - | - |
| | Muscidae | 3 | R | R | - | R | - | R |
| | *Austrosimulium* | 3 | - | R | R | R | C | R |
| | Tanyderidae | 4 | - | R | R | R | - | - |
| | | **No of taxa** | 28 | 26 | 22 | 22 | 25 | 20 |
| | | **MCI** | 139 | 123 | 102 | 92 | 94 | 91 |
| | | **SQMCIs** | 7.3 | 7.1 | 6.0 | 4.3 | 4.2 | 3.9 |
| | | **EPT (taxa)** | 18 | 14 | 9 | 8 | 8 | 6 |
| | | **%EPT (taxa)** | 64 | 54 | 41 | 36 | 32 | 30 |
| '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 14 October 2014

| Taxa List | Site Code / Sample Number | MCI score | MWH000380 / FWB13293 | MWH000490 / FWB13294 |
|---|---|---|---|---|
| **COELENTERATA** | Coelenterata | 3 | R | - |
| **NEMERTEA** | Nemertea | 3 | R | - |
| **NEMATODA** | Nematoda | 3 | R | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | XA | XA |
| **MOLLUSCA** | *Potamopyrgus* | 4 | R | A |
| **CRUSTACEA** | *Paracalliope* | 5 | R | VA |
| | Paraleptamphopidae | 5 | R | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | A | C |
| | *Coloburiscus* | 7 | - | R |
| | *Deleatidium* | 8 | - | VA |
| **PLECOPTERA (STONEFLIES)** | *Zelandobius* | 5 | R | A |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | - | VA |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | - | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C | A |
| | *Costachorema* | 7 | - | C |
| | *Hydrobiosis* | 5 | C | C |
| | *Oxyethira* | 2 | R | R |
| | *Pycnocentria* | 7 | - | C |
| | *Pycnocentrodes* | 5 | - | VA |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | C |
| | *Maoridiamesa* | 3 | C | A |
| | Orthocladiinae | 2 | A | A |
| | *Polypedilum* | 3 | R | R |
| | Tanytarsini | 3 | - | C |
| | Empididae | 3 | - | R |
| | *Austrosimulium* | 3 | R | R |
| | | **No of taxa** | 17 | 22 |
| | | **MCI** | 74 | 93 |
| | | **SQMCIs** | 1.5 | 3.3 |
| | | **EPT (taxa)** | 4 | 9 |
| | | **%EPT (taxa)** | 24 | 41 |
| '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 12 February 2015

| Taxa List | Site Code | MCI score | MWH000380 | MWH000490 |
|---|---|---|---|---|
| | Sample Number | | FWB15093 | FWB15094 |
| **COELENTERATA** | Coelenterata | 3 | R | - |
| **NEMERTEA** | Nemertea | 3 | R | C |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | C | VA |
| **MOLLUSCA** | *Ferrissia* | 3 | - | R |
| | *Potamopyrgus* | 4 | C | A |
| **CRUSTACEA** | Ostracoda | 1 | C | C |
| | *Paracalliope* | 5 | VA | VA |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | R | C |
| | *Coloburiscus* | 7 | - | R |
| | *Deleatidium* | 8 | - | VA |
| **PLECOPTERA (STONEFLIES)** | *Zelandobius* | 5 | - | R |
| **HEMIPTERA (BUGS)** | *Microvelia* | 3 | R | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | - | VA |
| | Hydraenidae | 8 | - | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C | XA |
| | *Costachorema* | 7 | - | C |
| | *Hydrobiosis* | 5 | R | VA |
| | *Neurochorema* | 6 | - | R |
| | *Polyplectropus* | 6 | R | - |
| | *Oxyethira* | 2 | - | C |
| | *Pycnocentrodes* | 5 | - | A |
| | *Triplectides* | 5 | C | - |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | - | R |
| | *Maoridiamesa* | 3 | - | R |
| | Orthocladiinae | 2 | C | VA |
| | *Polypedilum* | 3 | C | R |
| | Tanytarsini | 3 | R | A |
| | *Paradixa* | 4 | R | - |
| | Empididae | 3 | - | A |
| | Muscidae | 3 | - | C |
| | *Austrosimulium* | 3 | VA | C |
| | | **No of taxa** | 18 | 27 |
| | | **MCI** | 77 | 88 |
| | | **SQMCIs** | 3.9 | 4.2 |
| | | **EPT (taxa)** | 5 | 9 |
| | | **%EPT (taxa)** | 28 | 33 |
| '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 16 October 2014

| Taxa List | Site Code | MCI score | HTK000350 | HTK000425 | HTK000745 |
|---|---|---|---|---|---|
| | Sample Number | | FWB14286 | FWB14287 | FWB14288 |
| PLATYHELMINTHES (FLATWORMS) | *Cura* | 3 | - | - | R |
| NEMERTEA | Nemertea | 3 | - | - | R |
| ANNELIDA (WORMS) | Oligochaeta | 1 | A | A | XA |
| | Lumbricidae | 5 | - | R | R |
| MOLLUSCA | *Latia* | 5 | C | C | R |
| | *Physa* | 3 | - | - | R |
| | *Potamopyrgus* | 4 | C | A | VA |
| | Sphaeriidae | 3 | - | - | C |
| CRUSTACEA | *Paracalliope* | 5 | - | - | C |
| | Talitridae | 5 | R | - | - |
| EPHEMEROPTERA (MAYFLIES) | *Austroclima* | 7 | A | A | - |
| | *Coloburiscus* | 7 | VA | VA | C |
| | *Deleatidium* | 8 | VA | VA | R |
| | *Nesameletus* | 9 | C | - | - |
| | *Zephlebia group* | 7 | A | C | A |
| PLECOPTERA (STONEFLIES) | *Acroperla* | 5 | R | R | - |
| | *Zelandobius* | 5 | VA | A | R |
| COLEOPTERA (BEETLES) | Elmidae | 6 | VA | VA | XA |
| | Ptilodactylidae | 8 | R | C | - |
| MEGALOPTERA (DOBSONFLIES) | *Archichauliodes* | 7 | A | A | R |
| TRICHOPTERA (CADDISFLIES) | *Hydropsyche (Aoteapsyche)* | 4 | VA | A | R |
| | *Costachorema* | 7 | A | C | - |
| | *Hydrobiosis* | 5 | C | C | - |
| | *Hydrobiosella* | 9 | - | R | - |
| | *Beraeoptera* | 8 | - | R | - |
| | *Confluens* | 5 | R | - | - |
| | *Pycnocentria* | 7 | - | R | R |
| | *Pycnocentrodes* | 5 | R | A | R |
| DIPTERA (TRUE FLIES) | *Aphrophila* | 5 | R | R | - |
| | *Maoridiamesa* | 3 | R | - | - |
| | Orthocladiinae | 2 | C | A | C |
| | *Polypedilum* | 3 | R | R | - |
| | Tanytarsini | 3 | R | - | - |
| | Empididae | 3 | - | R | - |
| | Psychodidae | 1 | - | R | - |
| | *Austrosimulium* | 3 | A | A | R |
| | Tanyderidae | 4 | - | - | R |
| | | No of taxa | 25 | 26 | 21 |
| | | MCI | 103 | 105 | 92 |
| | | SQMCIs | 5.8 | 6.0 | 3.6 |
| | | EPT (taxa) | 12 | 13 | 7 |
| | | %EPT (taxa) | 48 | 50 | 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 12 February 2014

| Taxa List | Site Code / Sample Number | MCI score | HTK000350 / FWB15047 | HTK000425 / FWB15048 | HTK000745 / FWB15049 |
|---|---|---|---|---|---|
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | - | - | R |
| **NEMERTEA** | Nemertea | 3 | - | - | C |
| **NEMATODA** | Nematoda | 3 | - | - | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | A | C | XA |
| | *Branchiura* | 1 | - | - | R |
| **MOLLUSCA** | *Latia* | 5 | C | C | - |
| | *Potamopyrgus* | 4 | C | A | XA |
| | Sphaeriidae | 3 | - | - | A |
| **CRUSTACEA** | Ostracoda | 1 | - | - | C |
| | *Paranephrops* | 5 | R | - | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | A | VA | - |
| | *Coloburiscus* | 7 | VA | VA | - |
| | *Deleatidium* | 8 | VA | A | - |
| | *Nesameletus* | 9 | A | R | - |
| | *Rallidens* | 9 | C | - | - |
| | *Zephlebia group* | 7 | VA | C | - |
| **PLECOPTERA (STONEFLIES)** | *Zelandobius* | 5 | R | C | - |
| | *Zelandoperla* | 8 | R | R | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | VA | XA |
| | Ptilodactylidae | 8 | R | C | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A | C | R |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | VA | A | - |
| | *Costachorema* | 7 | A | - | - |
| | *Hydrobiosis* | 5 | A | A | - |
| | *Oxyethira* | 2 | C | - | - |
| | *Pycnocentria* | 7 | - | R | - |
| | *Pycnocentrodes* | 5 | R | R | - |
| | *Triplectides* | 5 | - | C | R |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | C | C | R |
| | *Chironomus* | 1 | - | - | R |
| | *Harrisius* | 6 | R | R | - |
| | *Maoridiamesa* | 3 | C | - | - |
| | Orthocladiinae | 2 | VA | C | R |
| | *Polypedilum* | 3 | - | C | R |
| | Tanypodinae | 5 | R | R | - |
| | Tanytarsini | 3 | A | R | R |
| | Empididae | 3 | C | C | - |
| | Muscidae | 3 | C | - | - |
| | Psychodidae | 1 | - | - | R |
| | *Austrosimulium* | 3 | C | C | R |
| | Tanyderidae | 4 | R | R | C |
| **ACARINA (MITES)** | Acarina | 5 | R | - | - |
| | | **No of taxa** | 31 | 27 | 19 |
| | | **MCI** | 104 | 105 | 62 |
| | | **SQMCIs** | 5.6 | 6.1 | 3.6 |
| | | **EPT (taxa)** | 12 | 12 | 1 |
| | | **%EPT (taxa)** | 39 | 44 | 5 |
| '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 14 October 2014

| Taxa List | Site Code | MCI score | KPK000250 | KPK000500 | KPK000660 | KPK000880 | KPK000990 |
|---|---|---|---|---|---|---|---|
| | Sample Number | | FWB14266 | FWB14267 | FWB14262 | FWB14265 | FWB14268 |
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | - | - | - | R | - |
| **NEMATODA** | Nematoda | 3 | - | - | - | R | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | C | A | A | A |
| | Lumbricidae | 5 | - | - | - | R | C |
| **MOLLUSCA** | *Potamopyrgus* | 4 | - | - | C | C | A |
| **CRUSTACEA** | *Paracalliope* | 5 | - | - | - | R | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | R | A | C | - | R |
| | *Coloburiscus* | 7 | XA | XA | VA | R | C |
| | *Deleatidium* | 8 | VA | VA | VA | VA | VA |
| | *Nesameletus* | 9 | C | A | - | - | - |
| | *Zephlebia group* | 7 | - | - | - | R | - |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | R | - | R | C | - |
| | *Austroperla* | 9 | R | R | - | - | - |
| | *Megaleptoperla* | 9 | C | C | R | - | - |
| | *Stenoperla* | 10 | R | - | - | - | - |
| | *Zelandobius* | 5 | R | - | R | R | C |
| | *Zelandoperla* | 8 | VA | A | - | - | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | A | VA | C | C |
| | Hydraenidae | 8 | R | R | - | - | - |
| | Ptilodactylidae | 8 | R | - | - | - | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | A | A | C | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | VA | VA | VA | R | - |
| | *Costachorema* | 7 | R | R | A | C | C |
| | *Hydrobiosis* | 5 | R | - | R | A | C |
| | *Hydrobiosella* | 9 | R | - | - | - | - |
| | *Hydrochorema* | 9 | R | - | - | - | - |
| | *Neurochorema* | 6 | - | R | - | - | - |
| | *Hydropsyche (Orthopsyche)* | 9 | R | - | - | - | - |
| | *Psilochorema* | 6 | R | - | - | - | - |
| | *Beraeoptera* | 8 | VA | A | R | - | - |
| | *Confluens* | 5 | - | R | - | - | - |
| | *Helicopsyche* | 10 | A | - | - | - | - |
| | *Olinga* | 9 | VA | C | R | - | - |
| | *Pycnocentria* | 7 | C | - | - | - | R |
| | *Pycnocentrodes* | 5 | A | VA | C | VA | XA |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | VA | VA | C | R |
| | Eriopterini | 5 | C | - | - | - | - |
| | *Maoridiamesa* | 3 | - | C | VA | VA | VA |
| | Orthocladiinae | 2 | C | R | VA | A | A |
| | Tanypodinae | 5 | - | - | R | - | - |
| | Tanytarsini | 3 | - | - | - | - | C |
| | Empididae | 3 | C | - | - | - | - |
| | *Austrosimulium* | 3 | - | R | - | R | R |
| | Tabanidae | 3 | - | - | R | - | - |
| **ACARINA (MITES)** | Acarina | 5 | - | - | R | - | - |
| | | **No of taxa** | 30 | 22 | 22 | 21 | 19 |
| | | **MCI** | 139 | 124 | 109 | 95 | 100 |
| | | **SQMCIs** | 7.0 | 6.4 | 5.0 | 4.9 | 5.0 |
| | | **EPT (taxa)** | 22 | 14 | 12 | 9 | 8 |
| | | **%EPT (taxa)** | 73 | 64 | 55 | 43 | 42 |
| '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 19 February 2015

| Taxa List | Site Code | MCI score | KPK000250 | KPK000500 | KPK000660 | KPK000880 | KPK000990 |
|---|---|---|---|---|---|---|---|
| | Sample Number | | FWB15146 | FWB15147 | FWB15152 | FWB15155 | FWB15150 |
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | - | - | R | R | - |
| **NEMERTEA** | Nemertea | 3 | - | - | - | C | A |
| **NEMATODA** | Nematoda | 3 | - | - | R | - | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | C | C | A | A |
| **MOLLUSCA** | *Ferrissia* | 3 | - | - | R | - | - |
| | *Potamopyrgus* | 4 | - | C | A | VA | VA |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C | VA | A | R | - |
| | *Coloburiscus* | 7 | VA | VA | A | R | R |
| | *Deleatidium* | 8 | VA | VA | VA | C | C |
| | *Nesameletus* | 9 | A | R | R | - | - |
| **PLECOPTERA (STONEFLIES)** | *Austroperla* | 9 | C | - | - | - | - |
| | *Megaleptoperla* | 9 | A | R | - | - | - |
| | *Stenoperla* | 10 | R | - | - | - | - |
| | *Zelandobius* | 5 | - | - | - | - | R |
| | *Zelandoperla* | 8 | C | - | - | - | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | C | A | VA | C | C |
| | Hydraenidae | 8 | R | C | R | - | - |
| | Ptilodactylidae | 8 | - | R | - | - | - |
| | Staphylinidae | 5 | - | - | R | - | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | A | A | A | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A | XA | XA | C | A |
| | *Costachorema* | 7 | - | C | A | - | - |
| | *Hydrobiosis* | 5 | C | VA | A | A | A |
| | *Neurochorema* | 6 | - | C | - | - | - |
| | *Psilochorema* | 6 | R | - | - | - | - |
| | *Beraeoptera* | 8 | C | A | R | - | - |
| | *Helicopsyche* | 10 | C | - | - | - | - |
| | *Olinga* | 9 | VA | R | R | - | - |
| | *Oxyethira* | 2 | - | C | C | A | C |
| | *Pycnocentrodes* | 5 | C | C | R | VA | A |
| | *Zelolessica* | 7 | R | - | - | - | - |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | A | R | - | - |
| | *Maoridiamesa* | 3 | - | VA | R | C | R |
| | Orthocladiinae | 2 | - | A | VA | VA | XA |
| | *Polypedilum* | 3 | C | - | - | - | - |
| | Tanytarsini | 3 | - | A | A | A | A |
| | Empididae | 3 | - | R | C | - | - |
| | Ephydridae | 4 | - | R | - | - | C |
| | Muscidae | 3 | - | A | C | C | C |
| | *Austrosimulium* | 3 | R | - | - | C | R |
| **ACARINA (MITES)** | Acarina | 5 | - | - | R | - | - |
| | | **No of taxa** | 22 | 26 | 27 | 18 | 18 |
| | | **MCI** | 139 | 110 | 100 | 84 | 83 |
| | | **SQMCIs** | 7.6 | 5.0 | 4.6 | 3.7 | 2.6 |
| | | **EPT (taxa)** | 16 | 12 | 10 | 6 | 6 |
| | | **%EPT (taxa)** | 73 | 46 | 37 | 33 | 33 |
| '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 16 October 2014

| Taxa List | Site Number | MCI score | | |
|---|---|---|---|---|
| | Site Code | | KTK000150 | KTK000248 |
| | Sample Number | | FWB14291 | FWB14292 |
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | - | C |
| **NEMERTEA** | Nemertea | 3 | - | R |
| **NEMATODA** | Nematoda | 3 | - | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | VA |
| **MOLLUSCA** | *Latia* | 5 | - | R |
| | *Potamopyrgus* | 4 | - | VA |
| | Sphaeriidae | 3 | - | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Acanthophlebia* | 9 | R | - |
| | *Ameletopsis* | 10 | R | - |
| | *Austroclima* | 7 | R | - |
| | *Coloburiscus* | 7 | A | C |
| | *Deleatidium* | 8 | VA | A |
| | *Nesameletus* | 9 | A | - |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | C | - |
| | *Austroperla* | 9 | C | - |
| | *Stenoperla* | 10 | R | - |
| | *Zelandobius* | 5 | A | A |
| | *Zelandoperla* | 8 | VA | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | R | VA |
| | Hydraenidae | 8 | R | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | VA |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | - | VA |
| | *Costachorema* | 7 | - | R |
| | *Hydrobiosis* | 5 | R | A |
| | *Hydrobiosella* | 9 | C | - |
| | *Neurochorema* | 6 | - | R |
| | *Hydropsyche (Orthopsyche)* | 9 | R | - |
| | *Beraeoptera* | 8 | - | R |
| | *Pycnocentrodes* | 5 | - | VA |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | C | C |
| | Eriopterini | 5 | R | - |
| | *Maoridiamesa* | 3 | - | C |
| | Orthocladiinae | 2 | A | A |
| | *Polypedilum* | 3 | C | - |
| | Tanytarsini | 3 | - | C |
| | Empididae | 3 | R | R |
| | *Austrosimulium* | 3 | - | A |
| | Tanyderidae | 4 | - | R |
| | | **No of taxa** | 22 | 25 |
| | | **MCI** | 135 | 90 |
| | | **SQMCIs** | 7.3 | 4.5 |
| | | **EPT (taxa)** | 14 | 9 |
| | | **%EPT (taxa)** | 64 | 36 |
| '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 17 February 2015

| Taxa List | Site Number | MCI score | | |
|---|---|---|---|---|
| | Site Code | | KTK000150 | KTK000248 |
| | Sample Number | | FWB15129 | FWB15130 |
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | - | R |
| **NEMERTEA** | Nemertea | 3 | - | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | VA |
| **MOLLUSCA** | *Potamopyrgus* | 4 | - | VA |
| **EPHEMEROPTERA (MAYFLIES)** | *Acanthophlebia* | 9 | R | - |
| | *Ameletopsis* | 10 | R | - |
| | *Austroclima* | 7 | R | C |
| | *Coloburiscus* | 7 | A | - |
| | *Deleatidium* | 8 | A | R |
| | *Nesameletus* | 9 | C | - |
| | *Rallidens* | 9 | - | R |
| | *Zephlebia group* | 7 | - | R |
| **PLECOPTERA (STONEFLIES)** | *Austroperla* | 9 | A | - |
| | *Megaleptoperla* | 9 | R | - |
| | *Stenoperla* | 10 | R | - |
| | *Zelandobius* | 5 | C | R |
| | *Zelandoperla* | 8 | C | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | R | A |
| | Hydraenidae | 8 | R | - |
| | Hydrophilidae | 5 | R | - |
| **NEUROPTERA** | *Kempynus* | 8 | R | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | - | A |
| | *Costachorema* | 7 | - | R |
| | *Hydrobiosis* | 5 | R | A |
| | *Hydrobiosella* | 9 | R | - |
| | *Neurochorema* | 6 | - | R |
| | *Hydropsyche (Orthopsyche)* | 9 | C | - |
| | *Psilochorema* | 6 | R | - |
| | *Olinga* | 9 | R | - |
| | *Oxyethira* | 2 | R | C |
| | *Pycnocentrodes* | 5 | - | A |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | R | R |
| | Eriopterini | 5 | R | - |
| | *Zelandotipula* | 6 | R | - |
| | *Maoridiamesa* | 3 | C | R |
| | Orthocladiinae | 2 | C | VA |
| | *Polypedilum* | 3 | C | - |
| | Tanypodinae | 5 | R | - |
| | Tanytarsini | 3 | - | C |
| | Empididae | 3 | R | C |
| | *Austrosimulium* | 3 | - | A |
| | Tabanidae | 3 | - | R |
| **ACARINA (MITES)** | Acarina | 5 | R | - |
| | | **No of taxa** | 31 | 24 |
| | | **MCI** | 130 | 93 |
| | | **SQMCIs** | 7.0 | 3.2 |
| | | **EPT (taxa)** | 16 | 10 |
| | | **%EPT (taxa)** | 52 | 42 |
| '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 17 February 2015

| Taxa List | Site Number | MCI score | | | |
|---|---|---|---|---|---|
| | Site Code | | KPA000250 | KPA000700 | KPA000950 |
| | Sample Number | | FWB14240 | FWB14241 | FWB14242 |
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | - | - | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | R | A |
| | Lumbricidae | 5 | - | - | C |
| **MOLLUSCA** | *Ferrissia* | 3 | - | - | R |
| | *Potamopyrgus* | 4 | R | C | A |
| **CRUSTACEA** | *Paracalliope* | 5 | - | - | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C | R | R |
| | *Coloburiscus* | 7 | VA | A | - |
| | *Deleatidium* | 8 | XA | VA | A |
| | *Nesameletus* | 9 | C | - | - |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | R | A | R |
| | *Zelandobius* | 5 | R | A | C |
| | *Zelandoperla* | 8 | A | R | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | A | C |
| | Hydraenidae | 8 | R | - | - |
| | Ptilodactylidae | 8 | - | - | R |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | C | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C | A | A |
| | *Costachorema* | 7 | R | A | C |
| | *Hydrobiosis* | 5 | R | A | C |
| | *Neurochorema* | 6 | R | - | - |
| | *Beraeoptera* | 8 | C | - | - |
| | *Confluens* | 5 | R | - | - |
| | *Olinga* | 9 | R | - | - |
| | *Oxyethira* | 2 | - | R | R |
| | *Pycnocentria* | 7 | R | - | - |
| | *Pycnocentrodes* | 5 | C | A | VA |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | C | A | C |
| | Eriopterini | 5 | R | - | - |
| | *Maoridiamesa* | 3 | C | VA | VA |
| | Orthocladiinae | 2 | C | A | VA |
| | Tanytarsini | 3 | - | A | R |
| | Empididae | 3 | - | C | C |
| | Psychodidae | 1 | - | - | R |
| | *Austrosimulium* | 3 | - | C | C |
| | | **No of taxa** | 24 | 21 | 25 |
| | | **MCI** | 121 | 95 | 88 |
| | | **SQMCIs** | 7.6 | 5.2 | 3.8 |
| | | **EPT (taxa)** | 16 | 10 | 8 |
| | | **%EPT (taxa)** | 67 | 48 | 32 |
| '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 17 February 2015

| Taxa List | Site Number | MCI score | | | |
|---|---|---|---|---|---|
| | Site Code | | KPA000250 | KPA000700 | KPA000950 |
| | Sample Number | | FWB15126 | FWB15127 | FWB15128 |
| **NEMATODA** | Nematoda | 3 | - | R | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | - | A | C |
| | Lumbricidae | 5 | - | - | C |
| **MOLLUSCA** | *Potamopyrgus* | 4 | - | C | A |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C | - | C |
| | *Coloburiscus* | 7 | VA | C | - |
| | *Deleatidium* | 8 | XA | C | R |
| | *Nesameletus* | 9 | C | - | - |
| | *Zephlebia group* | 7 | R | R | - |
| **PLECOPTERA (STONEFLIES)** | *Megaleptoperla* | 9 | R | - | - |
| | *Zelandoperla* | 8 | R | - | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | C | C |
| | Hydraenidae | 8 | C | - | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | XA | A | XA |
| | *Costachorema* | 7 | A | - | - |
| | *Hydrobiosis* | 5 | A | C | A |
| | *Beraeoptera* | 8 | R | - | - |
| | *Olinga* | 9 | C | - | - |
| | *Oxyethira* | 2 | - | C | R |
| | *Pycnocentrodes* | 5 | C | C | A |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | A | C | C |
| | Eriopterini | 5 | R | - | - |
| | Hexatomini | 5 | R | - | - |
| | *Maoridiamesa* | 3 | VA | A | R |
| | Orthocladiinae | 2 | VA | A | VA |
| | Tanypodinae | 5 | R | - | - |
| | Tanytarsini | 3 | - | C | C |
| | Empididae | 3 | - | A | C |
| | Muscidae | 3 | C | C | C |
| | *Austrosimulium* | 3 | R | A | C |
| | Tabanidae | 3 | R | - | - |
| | | **No of taxa** | 25 | 19 | 18 |
| | | **MCI** | 118 | 85 | 84 |
| | | **SQMCIs** | 5.6 | 3.7 | 3.9 |
| | | **EPT (taxa)** | 13 | 6 | 5 |
| | | **%EPT (taxa)** | 52 | 32 | 28 |
| '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 23 October 2014

| Taxa List | Site Number | MCI score | | |
|---|---|---|---|---|
| | Site Code | | KRP000300 | KRP000660 |
| | Sample Number | | FWB14330 | FWB14331 |
| PLATYHELMINTHES (FLATWORMS) | *Cura* | 3 | R | - |
| NEMATODA | Nematoda | 3 | - | R |
| ANNELIDA (WORMS) | Oligochaeta | 1 | A | VA |
| MOLLUSCA | *Potamopyrgus* | 4 | A | C |
| EPHEMEROPTERA (MAYFLIES) | *Austroclima* | 7 | C | VA |
| | *Coloburiscus* | 7 | C | VA |
| | *Deleatidium* | 8 | C | VA |
| | *Zephlebia group* | 7 | VA | VA |
| PLECOPTERA (STONEFLIES) | *Acroperla* | 5 | R | - |
| | *Zelandobius* | 5 | - | A |
| COLEOPTERA (BEETLES) | Elmidae | 6 | R | VA |
| | Hydraenidae | 8 | - | R |
| | Ptilodactylidae | 8 | R | - |
| MEGALOPTERA (DOBSONFLIES) | *Archichauliodes* | 7 | A | A |
| TRICHOPTERA (CADDISFLIES) | *Hydropsyche (Aoteapsyche)* | 4 | C | VA |
| | *Costachorema* | 7 | - | C |
| | *Hydrobiosis* | 5 | R | A |
| | *Hydrobiosella* | 9 | - | R |
| | *Neurochorema* | 6 | - | C |
| | *Hydropsyche (Orthopsyche)* | 9 | R | R |
| | Oeconesidae | 5 | - | R |
| | *Pycnocentria* | 7 | - | R |
| | *Pycnocentrodes* | 5 | - | VA |
| DIPTERA (TRUE FLIES) | *Aphrophila* | 5 | R | C |
| | *Maoridiamesa* | 3 | R | A |
| | Orthocladiinae | 2 | C | A |
| | *Polypedilum* | 3 | C | R |
| | Tanypodinae | 5 | R | R |
| | Tanytarsini | 3 | - | R |
| | Empididae | 3 | - | C |
| | *Austrosimulium* | 3 | R | C |
| | | No of taxa | 20 | 28 |
| | | MCI | 102 | 105 |
| | | SQMCIs | 5.7 | 5.5 |
| | | EPT (taxa) | 8 | 14 |
| | | %EPT (taxa) | 40 | 50 |
| '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 11 February 2015

| Taxa List | Site Number | MCI score | | |
|---|---|---|---|---|
| | Site Code | | KRP000300 | KRP000660 |
| | Sample Number | | FWB15078 | FWB15079 |
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | C | - |
| **NEMERTEA** | Nemertea | 3 | R | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | A | C |
| **MOLLUSCA** | *Potamopyrgus* | 4 | VA | A |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | A | A |
| | *Coloburiscus* | 7 | A | A |
| | *Deleatidium* | 8 | - | R |
| | *Nesameletus* | 9 | R | - |
| | *Zephlebia group* | 7 | VA | VA |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | VA |
| | Ptilodactylidae | 8 | R | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A | XA |
| | *Costachorema* | 7 | - | R |
| | *Hydrobiosis* | 5 | C | A |
| | *Neurochorema* | 6 | - | C |
| | *Psilochorema* | 6 | - | R |
| | Oeconesidae | 5 | - | R |
| | *Oxyethira* | 2 | - | R |
| | *Pycnocentria* | 7 | R | - |
| | *Pycnocentrodes* | 5 | - | R |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | - | A |
| | Eriopterini | 5 | - | R |
| | *Maoridiamesa* | 3 | - | R |
| | Orthocladiinae | 2 | - | A |
| | *Polypedilum* | 3 | R | - |
| | Tanytarsini | 3 | - | C |
| | Empididae | 3 | R | C |
| | Muscidae | 3 | - | C |
| | *Austrosimulium* | 3 | - | C |
| | Tanyderidae | 4 | R | R |
| | | **No of taxa** | 17 | 26 |
| | | **MCI** | 104 | 93 |
| | | **SQMCIs** | 5.5 | 4.8 |
| | | **EPT (taxa)** | 7 | 11 |
| | | **%EPT (taxa)** | 41 | 42 |
| 'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa | | |

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

**Table 170** Macroinvertebrate fauna of the Waiokura Stream:spring SEM survey sampled on 14 October 2014

| Taxa List | Site Number | MCI score | | |
|---|---|---|---|---|
| | Site Code | | WKR000500 | WKR000700 |
| | Sample Number | | FWB14259 | FWB14260 |
| NEMATODA | Nematoda | 3 | R | - |
| ANNELIDA (WORMS) | Oligochaeta | 1 | A | C |
| MOLLUSCA | *Potamopyrgus* | 4 | A | R |
| CRUSTACEA | Isopoda | 5 | R | - |
| | *Paracalliope* | 5 | - | R |
| | Paraleptamphopidae | 5 | C | - |
| EPHEMEROPTERA (MAYFLIES) | *Austroclima* | 7 | VA | VA |
| | *Coloburiscus* | 7 | R | A |
| | *Deleatidium* | 8 | - | R |
| | *Neozephlebia* | 7 | R | - |
| | *Zephlebia group* | 7 | A | VA |
| PLECOPTERA (STONEFLIES) | *Zelandobius* | 5 | A | C |
| COLEOPTERA (BEETLES) | Elmidae | 6 | VA | A |
| MEGALOPTERA (DOBSONFLIES) | *Archichauliodes* | 7 | C | C |
| TRICHOPTERA (CADDISFLIES) | *Hydropsyche (Aoteapsyche)* | 4 | A | A |
| | *Hydrobiosis* | 5 | R | R |
| | *Psilochorema* | 6 | - | R |
| | *Confluens* | 5 | R | - |
| | *Helicopsyche* | 10 | C | - |
| | *Pycnocentria* | 7 | C | R |
| | *Pycnocentrodes* | 5 | R | R |
| DIPTERA (TRUE FLIES) | *Chironomus* | 1 | R | - |
| | Orthocladiinae | 2 | R | - |
| | *Austrosimulium* | 3 | - | R |
| | Tanyderidae | 4 | R | - |
| | | No of taxa | 21 | 16 |
| | | MCI | 102 | 109 |
| | | SQMCIs | 5.8 | 6.5 |
| | | EPT (taxa) | 11 | 10 |
| | | %EPT (taxa) | 52 | 63 |
| '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 19 February 2015

| Taxa List | Site Number | MCI score | | |
|---|---|---|---|---|
| | Site Code | | WKR000500 | WKR000700 |
| | Sample Number | | FWB15156 | FWB15158 |
| **NEMERTEA** | Nemertea | 3 | - | C |
| **NEMATODA** | Nematoda | 3 | R | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | C | C |
| | Lumbricidae | 5 | R | - |
| **MOLLUSCA** | *Potamopyrgus* | 4 | C | C |
| **CRUSTACEA** | *Paracalliope* | 5 | - | R |
| | Paraleptamphopidae | 5 | - | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | VA | VA |
| | *Coloburiscus* | 7 | A | A |
| | *Deleatidium* | 8 | C | C |
| | *Zephlebia group* | 7 | VA | VA |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | VA |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | A | A |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | VA | VA |
| | *Hydrobiosis* | 5 | C | C |
| | *Neurochorema* | 6 | R | - |
| | *Psilochorema* | 6 | - | R |
| | *Beraeoptera* | 8 | R | - |
| | *Pycnocentria* | 7 | C | - |
| **DIPTERA (TRUE FLIES)** | *Harrisius* | 6 | R | - |
| | *Polypedilum* | 3 | - | R |
| | Tanytarsini | 3 | R | R |
| | *Austrosimulium* | 3 | C | R |
| | Tanyderidae | 4 | C | R |
| **ACARINA (MITES)** | Acarina | 5 | - | R |
| | | **No of taxa** | 19 | 19 |
| | | **MCI** | 106 | 98 |
| | | **SQMCIs** | 6.0 | 6.0 |
| | | **EPT (taxa)** | 9 | 7 |
| | | **%EPT (taxa)** | 47 | 37 |
| '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 20 November 2014

| Taxa List | Site Number | MCI score | | | |
|---|---|---|---|---|---|
| | Site Code | | TNH000090 | TNH000200 | TNH000515 |
| | Sample Number | | FWB14352 | FWB14353 | FWB14354 |
| **PLATYHELMINTHES (FLATWORMS)** | *Cura* | 3 | R | - | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | C | R | A |
| **MOLLUSCA** | *Latia* | 5 | - | R | R |
| | *Potamopyrgus* | 4 | A | C | C |
| **CRUSTACEA** | *Phreatogammarus* | 5 | - | - | C |
| | *Paranephrops* | 5 | - | R | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | A | VA | A |
| | *Coloburiscus* | 7 | - | C | C |
| | *Deleatidium* | 8 | VA | VA | C |
| | *Neozephlebia* | 7 | R | - | - |
| | *Rallidens* | 9 | R | - | - |
| | *Zephlebia group* | 7 | VA | C | - |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | C | A | - |
| | *Zelandobius* | 5 | R | A | R |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | A | VA | VA |
| | Staphylinidae | 5 | R | - | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R | C | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | R | A | VA |
| | *Costachorema* | 7 | - | R | C |
| | Ecnomidae/Psychomyiidae | 6 | R | - | - |
| | *Hydrobiosis* | 5 | R | - | C |
| | *Psilochorema* | 6 | R | - | - |
| | *Olinga* | 9 | - | R | - |
| | *Oxyethira* | 2 | R | R | - |
| | *Pycnocentrodes* | 5 | - | C | XA |
| | *Triplectides* | 5 | R | - | - |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | R | A | R |
| | *Harrisius* | 6 | - | R | - |
| | *Maoridiamesa* | 3 | R | C | R |
| | Orthocladiinae | 2 | R | C | C |
| | *Polypedilum* | 3 | R | - | - |
| | Tanypodinae | 5 | - | R | - |
| | Tanytarsini | 3 | R | C | C |
| | Empididae | 3 | R | R | - |
| | *Austrosimulium* | 3 | A | A | R |
| | Tanyderidae | 4 | R | - | - |
| | | **No of taxa** | 27 | 25 | 19 |
| | | **MCI** | 95 | 99 | 97 |
| | | **SQMCIs** | 6.5 | 6.2 | 5.0 |
| | | **EPT (taxa)** | 12 | 10 | 8 |
| | | **%EPT (taxa)** | 44 | 40 | 42 |
| '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 18 February 2015

| Taxa List | Site Number | MCI score | | | |
|---|---|---|---|---|---|
| | Site Code | | TNH000090 | TNH000200 | TNH000515 |
| | Sample Number | | FWB15139 | FWB15140 | FWB15141 |
| **NEMERTEA** | Nemertea | 3 | - | R | - |
| **NEMATODA** | Nematoda | 3 | - | R | - |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | R | C | C |
| **MOLLUSCA** | *Latia* | 5 | - | R | R |
| | *Potamopyrgus* | 4 | VA | C | A |
| **CRUSTACEA** | *Paracalliope* | 5 | - | R | - |
| | *Phreatogammarus* | 5 | - | - | C |
| | *Paranephrops* | 5 | R | R | - |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | VA | VA | A |
| | *Coloburiscus* | 7 | C | A | C |
| | *Deleatidium* | 8 | VA | A | C |
| | *Mauiulus* | 5 | R | R | R |
| | *Neozephlebia* | 7 | R | - | - |
| | *Rallidens* | 9 | C | R | - |
| | *Zephlebia group* | 7 | A | A | R |
| **PLECOPTERA (STONEFLIES)** | *Acroperla* | 5 | - | R | - |
| | *Austroperla* | 9 | - | R | - |
| | *Megaleptoperla* | 9 | C | R | - |
| | *Zelandobius* | 5 | R | C | - |
| | *Zelandoperla* | 8 | - | R | - |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA | VA | VA |
| | Hydraenidae | 8 | - | R | R |
| | Staphylinidae | 5 | R | R | - |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R | A | C |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | A | VA | VA |
| | *Costachorema* | 7 | - | R | - |
| | *Hydrobiosis* | 5 | C | A | C |
| | *Neurochorema* | 6 | - | C | - |
| | *Psilochorema* | 6 | C | R | - |
| | *Olinga* | 9 | - | R | - |
| | *Oxyethira* | 2 | R | R | R |
| | *Pycnocentrodes* | 5 | - | R | VA |
| **DIPTERA (TRUE FLIES)** | *Aphrophila* | 5 | - | C | R |
| | Eriopterini | 5 | R | - | - |
| | Hexatomini | 5 | R | - | - |
| | *Chironomus* | 1 | R | - | - |
| | Orthocladiinae | 2 | - | A | VA |
| | *Polypedilum* | 3 | - | - | A |
| | Tanypodinae | 5 | C | - | - |
| | Tanytarsini | 3 | R | VA | R |
| | Empididae | 3 | - | R | - |
| | *Austrosimulium* | 3 | C | C | A |
| **ACARINA (MITES)** | Acarina | 5 | R | - | - |
| | | **No of taxa** | 26 | 35 | 21 |
| | | **MCI** | 105 | 109 | 97 |
| | | **SQMCIs** | 6.1 | 5.2 | 4.3 |
| | | **EPT (taxa)** | 12 | 18 | 8 |
| | | **%EPT (taxa)** | 46 | 51 | 38 |
| 'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa | | | |

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

**Table 174** Macroinvertebrate fauna of the Herekawe Stream: spring SEM survey sampled 16 October 2014

| Taxa List | Site Number | MCI score | |
|---|---|---|---|
| | Site Code | | HRK000085 |
| | Sample Number | | FWB14289 |
| ANNELIDA (WORMS) | Oligochaeta | 1 | A |
| MOLLUSCA | *Potamopyrgus* | 4 | XA |
| | Sphaeriidae | 3 | R |
| CRUSTACEA | *Paracalliope* | 5 | XA |
| | *Paranephrops* | 5 | R |
| EPHEMEROPTERA (MAYFLIES) | *Austroclima* | 7 | C |
| | *Coloburiscus* | 7 | C |
| | *Zephlebia group* | 7 | R |
| PLECOPTERA (STONEFLIES) | *Acroperla* | 5 | R |
| ODONATA (DRAGONFLIES) | *Antipodochlora* | 5 | R |
| COLEOPTERA (BEETLES) | Elmidae | 6 | C |
| TRICHOPTERA (CADDISFLIES) | *Hydrobiosis* | 5 | R |
| | *Psilochorema* | 6 | R |
| | *Oxyethira* | 2 | R |
| | *Triplectides* | 5 | C |
| DIPTERA (TRUE FLIES) | *Aphrophila* | 5 | C |
| | Orthocladiinae | 2 | A |
| | *Polypedilum* | 3 | R |
| | *Austrosimulium* | 3 | C |
| | | No of taxa | 19 |
| | | MCI | 91 |
| | | SQMCIs | 4.4 |
| | | EPT (taxa) | 7 |
| | | %EPT (taxa) | 37 |
| '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 20 February 2015

| Taxa List | Site Number | MCI score | |
|---|---|---|---|
| | Site Code | | HRK000085 |
| | Sample Number | | FWB15168 |
| **NEMERTEA** | Nemertea | 3 | R |
| **ANNELIDA (WORMS)** | Oligochaeta | 1 | A |
| **HIRUDINEA (LEECHES)** | Hirudinea | 3 | R |
| **MOLLUSCA** | *Potamopyrgus* | 4 | XA |
| | Sphaeriidae | 3 | R |
| **CRUSTACEA** | Ostracoda | 1 | R |
| | *Paracalliope* | 5 | XA |
| | *Paranephrops* | 5 | R |
| **EPHEMEROPTERA (MAYFLIES)** | *Austroclima* | 7 | C |
| | *Coloburiscus* | 7 | C |
| **PLECOPTERA (STONEFLIES)** | *Megaleptoperla* | 9 | A |
| **COLEOPTERA (BEETLES)** | Elmidae | 6 | VA |
| **MEGALOPTERA (DOBSONFLIES)** | *Archichauliodes* | 7 | R |
| **TRICHOPTERA (CADDISFLIES)** | *Hydropsyche (Aoteapsyche)* | 4 | C |
| | *Hydrobiosis* | 5 | C |
| | *Hydropsyche (Orthopsyche)* | 9 | R |
| | *Polyplectropus* | 6 | R |
| | *Psilochorema* | 6 | R |
| | *Hudsonema* | 6 | R |
| | *Oxyethira* | 2 | R |
| | *Pycnocentrodes* | 5 | C |
| | *Triplectides* | 5 | A |
| **DIPTERA (TRUE FLIES)** | Eriopterini | 5 | R |
| | Hexatomini | 5 | R |
| | *Paralimnophila* | 6 | R |
| | *Chironomus* | 1 | R |
| | Orthocladiinae | 2 | R |
| | Empididae | 3 | R |
| | *Austrosimulium* | 3 | A |
| | | **No of taxa** | 29 |
| | | **MCI** | 92 |
| | | **SQMCIs** | 4.6 |
| | | **EPT (taxa)** | 11 |
| | | **%EPT (taxa)** | 38 |
| '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, 2013-2014 and historical MCI scores, predicted scores and 1995-2014 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 2014

| Site code | River Environment Classification (REC) | Altitude (masl) | Distance from National Park (km) | MCI Values | | | | | | | | | | | Trends (1995-2013) | | | Ecological importance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | SEM 1995 to 2015 | | | | | | | | Predicted | | | | | | |
| | | | | Spring 2014 | Summer 2015 | 1995-2015 | | | | Median stream 'health' category | | Altitude[1] | Distance[1] | REC[2] | p | p>FDR | + / - | |
| | | | | | | Range | Medians | | | | | | | | | | | |
| | | | | | | | Spring | Summer | Overall | Generic[3] | Predicted [4] | | | | | | | |
| STY000300 | CX/H/VA/S/MO/MG | 160 | 7.3 | (108) | (106) | 64-160 | 112 | 113 | 113 | Good | Expected | 101[+] | 109[0] | 128[-] | 0.082 | 129 | -ve | - |
| STY000400 | CX/H/VA/S/MO/MG | 70 | 12.5 | (107) | (120) | 0-160 | 108 | 109 | 108 | Good | Expected | 92[+] | 103[0] | 115[0] | 0.807 | 0.857 | -ve | - |
| TMR000150 | CX/H/VA/IF/LO/HG | 420 | 0 | 139 | 138 | 119-144 | 136 | 138 | 138 | Very good | Expected | 127[0] | 132[0] | 141[0] | 0.828 | 0.861 | +ve | - |
| TMR000375 | CX/L/VA/P/MO/MG | 100 | 10.9 | 102 | 92 | 89-120 | 104 | 102 | 102 | Good | Expected | 95[0] | 105[0] | 117[-] | <0.0002 | <0.001 | +ve | Yes |
| MRK000420 | WW/L/VA/P/MO/LG | 60 | N/A | 90 | 85 | 75-105 | 92 | 89 | 90 | Fair | Expected | 91[0] | N/A | 92[0] | <0.0001 | <0.001 | +ve | Yes |
| WGA000260 | CX/L/VA/P/MO/LG | 140 | 16.1 | 99 | 96 | 82-112 | 98 | 96 | 96 | Fair | Expected | 99[0] | 100[0] | 99[0] | 0.038 | 0.069 | +ve | - |
| WGA000450 | WW/L/VA/P/MO/LG | 20 | 31.2 | 92 | 89 | 72-102 | 93 | 87 | 90 | Fair | Expected | 86[0] | 93[0] | 88[0] | 0.0004 | 0.001 | +ve | Yes |
| WKH000100 | CX/H/VA/IF/LO/HG | 460 | 0 | 128 | 130 | 115-147 | 131 | 125 | 129 | Very good | Expected | 131[0] | 132[0] | 137[0] | 0.531 | 0.617 | +ve | - |
| WKH000500 | CX/H/VA/P/MO/MG | 175 | 10.6 | 115 | 108 | 87-122 | 112 | 108 | 110 | Good | Expected | 102[0] | 105[0] | 115[0] | 0.002 | 0.004 | +ve | Yes |
| WKH000920 | CX/H/VA/P/HO/LG | 20 | 26.6 | 88 | 79 | 71-110 | 100 | 91 | 95 | Fair | Expected | 86[0] | 95[0] | 97[0] | 0.501 | 0.617 | +ve | - |
| WKH000950 | CX/H/VA/P/HO/LG | 2 | 28.4 | 94 | 75 | 70-111 | 92 | 82 | 88 | Fair | Expected | 85[0] | 94[0] | 97[0] | 0.467 | 0.640 | +ve | - |
| MGE000970 | CX/L/VA/P/MO/LG | 90 | 15.6 | 94 | 94 | 86-113 | 104 | 99 | 102 | Good | Expected | 94[0] | 101(0) | 101[0] | 0.074 | 0.122 | -ve | - |
| MGN000195 | CX/H/VA/P/MO/LG | 330 | 8.7 | 129 | 123 | 113-143 | 130 | 123 | 126 | Very good | Better than | 118[0] | 107[+] | 124[0] | 0.458 | 0.580 | -ve | - |
| MGN000427 | CX/L/VA/P/HO/MG | 140 | 37.9 | 104 | 96 | 77-115 | 102 | 96 | 98 | Fair | Expected | 99[0] | 91[0] | 103[0] | 0.226 | 0.309 | +ve | - |
| MKW000200 | CX/H/VA/IF/MO/MG | 380 | 2.3 | 130 | 126 | 100-141 | 132 | 123 | 128 | Very good | Expected | 123[0] | 121[0] | 130[0] | 0.756 | 0.819 | -ve | - |
| MKW000300 | CX/H/VA/P/MO/LG | 150 | 15.5 | 118 | 108 | 90-115 | 108 | 103 | 107 | Good | Expected | 100[0] | 101[0] | 111[0] | 0.005 | 0.011 | +ve | Yes |
| WTR000850 | WX/L/SS/P/HO/LG | 15 | N/A | 89 | 88 | 64-107 | 91 | 81 | 86 | Fair | Expected | 85[0] | N/A | 98[-] | 0.020 | 0.037 | +ve | Yes |
| MGT000488 | WN/L/VA/P/LO/LG | 30 | N/A | 78 | 73 | 56-91 | 78 | 79 | 78 | Poor | N/A[s] | N/A | N/A | 80[0] | 0.241 | 0.322 | +ve | - |
| MGT000520 | WW/L/VA/U/LO/LG | 20 | N/A | 67 | 72 | 44-78 | 85 | 67 | 65 | Poor | N/A[s] | N/A | N/A | 88[-] | <0.0001 | <0.0001 | +ve | Yes |
| WMK000100 | WW/L/VA/P/LO/HG | 160 | 0 | 127 | 131 | 121-141 | 131 | 130 | 131 | Very good | Expected | 101[+] | 132[0] | 128[0] | 0.920 | 0.920 | +ve | - |
| WMK000298 | WW/L/VA/P/MO/MG | 1 | 4.0 | 91 | 93 | 75-101 | 92 | 88 | 91 | Fair | Expected | 85[0] | 116[-] | 103[-] | 0.010 | 0.030 | +ve | No |
| WAI000110 | WW/L/VA/P/MO/LG | 50 | N/A | 99 | 88 | 80-100 | 92 | 88 | 90 | Fair | N/A | N/A | N/A | 91[0] | 0.001 | 0.004 | +ve | No |
| PNH000200 | CX/H/YA/IF/MO/MG | 270 | 4.4 | 133 | 126 | 104-137 | 128 | 120 | 122 | Very good | Expected | 112[0] | 115[0] | 121[0] | 0.002 | 0.005 | +ve | Yes |
| PNH000900 | CW/L/VA/P/MO/LG | 20 | 20.9 | 114 | 99 | 70-114 | 92 | 84 | 89 | Fair | Expected | 86[0] | 98[0] | 100[-] | <0.0001 | <0.001 | +ve | Yes |
| PAT000200 | CX/H/VA/IF/MO/MG | 500 | 1.9 | 138 | 138 | 127-145 | 138 | 137 | 138 | Very good | Expected | 135[0] | 125[+] | 129[0] | 0.531 | 0.617 | +ve | - |
| PAT000315 | CX/H/VA/P/MO/LG | 300 | 124 | 110 | 111 | 99-130 | 116 | 108 | 110 | Good | Expected | 115[0] | 103[0] | 112[0] | 0.161 | 0.239 | +ve | - |
| PAT000360 | CW/L/VA/P/HO/LG | 240 | 19.2 | 101 | 101 | 86-105 | 100 | 97 | 98 | Fair | Expected | 109[-] | 99[0] | 109[-] | 0.191 | 0.276 | +ve | - |
| MGH000950 | CW/L/SS/P/HO/LG | 120 | N/A | 103 | 98 | 90 | 93 | 88 | 91 | Fair | N/A | N/A | N/A | 117[-] | <0.0001 | <0.0001 | +ve | Yes |
| WGG000115 | CX/H/VA/IF/LO/MG | 540 | 0.7 | 125 | 139 | 122-139 | 132 | 134 | 132 | Very good | Expected | 140[0] | 132[0] | 131[0] | 0.219 | 0.308 | +ve | - |
| WGG000150 | CX/H/VA/P/LO/MG | 380 | 7.2 | 128 | 123 | 119-139 | 132 | 128 | 130 | Very good | Better than | 123[0] | 110[+] | 124[0] | 0.534 | 0.617 | +ve | - |
| WGG000500 | CW/L/VA/P/MO/LG | 200 | 23.0 | 104 | 102 | 91-124 | 103 | 101 | 102 | Good | Expected | 105[0] | 97[0] | 110[0] | <0.0001 | <0.001 | +ve | No |
| WGG000665 | CW/L/VA/P/HO/MG | 180 | 29.6 | 106 | 92 | 77-111 | 98 | 93 | 95 | Fair | Expected | 103[0] | 94[0] | 102[0] | <0.001 | 0.003 | +ve | Yes |
| WGG000895 | CW/L/VA/P/HO/LG | 40 | 63.0 | 102 | 94 | 73-106 | 97 | 94 | 95 | Fair | Expected | 89[0] | 85[0] | 92[0] | 0.074 | 0.122 | +ve | - |
| WGG000995 | CW/L/VA/P/HO/MG | 5 | 66.6 | 98 | 91 | 69-100 | 93 | 86 | 91 | Fair | Expected | 85[0] | 85[0] | 95[0] | 0.001 | 0.004 | +ve | Yes |
| MWH000380 | WW/L/M/P/MO/LG | 200 | N/A | 74 | 77 | 58-85 | 76 | 74 | 75 | Poor | N/A[s] | N/A | N/A | 92[-] | 0.002 | 0.004 | +ve | No |
| MWH000490 | CN/L/VA/P/MO/LG | 190 | N/A | 97 | 88 | 63-102 | 81 | 78 | 79 | Poor | Worse than | 104[-] | N/A | 93[-] | <0.0001 | <0.001 | +ve | Yes |
| HTK000350 | WX/L/VA/P/MO/LG | 60 | N/A | 103 | 103 | 79-114 | 100 | 94 | 96 | Fair | Expected | 91[0] | N/A | 95[0] | <0.0001 | <0.001 | +ve | Yes |
| HTK000425 | WW/L/VA/P/MO/LG | 30 | N/A | 105 | 105 | 91-115 | 105 | 102 | 104 | Good | Better than | 87[+] | N/A | 92[+] | 0.0002 | <0.001 | +ve | No |
| HTK000745 | WW/L/VA/U/MO/MG | 5 | N/A | 92 | 62 | 62 | 85 | 86 | 86 | Fair | Expected | 85[0] | N/A | 93[0] | 0.878 | 0.895 | (-ve) | - |
| KPK000250 | CX/H/VA/IF/MO/MG | 380 | 3.3 | 139 | 139 | 124-138 | 130 | 128 | 129 | Very good | Expected | 123[0] | 118[+] | 137[0] | 0.597 | 0.660 | +ve | - |
| KPK000500 | CX/H/VA/P/MO/MG | 260 | 9.2 | 124 | 110 | 98-133 | 121 | 111 | 117 | Good | Expected | 111[0] | 107[0] | 127[0] | <0.0002 | <0.001 | +ve | Yes |
| KPK000660 | CX/H/VA/P/MO/LG | 170 | 15.5 | 109 | 100 | 71-128 | 106 | 102 | 103 | Good | Expected | 102[0] | 101[0] | 122[-] | <0.0001 | <0.0001 | +ve | Yes |
| KPK000880 | CW/H/VA/P/MO/LG | 60 | 25.7 | 95 | 84 | 66-110 | 93 | 88 | 91 | Fair | Expected | 91[0] | 95[0] | 106[-] | 0.013 | 0.026 | +ve | Yes |
| KPK000990 | CW/L/VA/P/HO/LG | 5 | 31.1 | 100 | 83 | 69-103 | 94 | 88 | 91 | Fair | Expected | 85[0] | 93[0] | 96[0] | 0.010 | 0.020 | +ve | Yes |
| KTK000150 | CW/L/VA/P/HO/LG | 420 | 0 | 135 | 130 | 112-148 | 137 | 135 | 136 | Very good | Expected | 127[0] | 132[0] | 131[0] | 0.071 | 0.122 | -ve | - |
| KTK000248 | WX/L/VA/P/MO/LG | 5 | 18.1 | 90 | 93 | 87-118 | 102 | 103 | 102 | Good | Expected | 85[+] | 99[0] | 96[0] | 0.356 | 0.463 | +ve | - |
| KPA000250 | CX/H/VA/P/MO/MG | 240 | 5.7 | 121 | 118 | 83-130 | 119 | 110 | 113 | Good | Expected | 109[0] | 112[0] | 111[0] | <0.0001 | <0.0001 | +ve | Yes |
| KPA000700 | CX/H/VA/P/MO/MG | 140 | 13.5 | 95 | 85 | 78-118 | 96 | 93 | 95 | Fair | Expected | 99[0] | 103[0] | 105[0] | 0.0007 | 0.002 | +ve | Yes |
| KPA000950 | CX/L/VA/P/MO/LG | 20 | 25.2 | 88 | 84 | 76-101 | 89 | 81 | 86 | Fair | Expected | 86[0] | 96[0] | 99[-] | 0.122 | 0.187 | +ve | - |
| KRP000300 | WX/L/VA/P/LO/LG | 180 | N/A | 102 | 104 | 80-104 | 94 | 95 | 94 | Fair | Expected | 103[0] | N/A | 92[0] | <0.0001 | <0.0001 | +ve | Yes |
| KRP000660 | WW/L/VA/P/LO/LG | 120 | N/A | 105 | 93 | 70-112 | 94 | 91 | 93 | Fair | Expected | 97[0] | N/A | 102[0] | <0.0001 | <0.001 | +ve | Yes |
| WKR000500 | WW/L/VA/P/MO/LG | 150 | N/A | 102 | 108 | 88-114 | 102 | 98 | 99 | Fair | Expected | 100[0] | N/A | 97[0] | N/T | N/T | +ve | N/% |
| WKR000700 | WW/L/VA/P/MO/LG | 70 | N/A | 109 | 98 | 92-109 | 99 | 99 | 99 | Fair | Expected | 92[0] | N/A | 95[0] | N/T | N/T | +ve | N/T |
| TNH000090 | WW/L/SS/P/MO/LG | 85 | N/A | 95 | 105 | 90-107 | 96 | 101 | 98 | Fair | N/A | N/A | N/A | 110[-] | N/T | N/T | +ve | N/T |
| TNH000200 | WW/L/SS/P/HO/LG | 65 | N/A | 99 | 109 | 92-108 | 104 | 104 | 104 | Good | N/A | N/A | N/A | 108[0] | N/T | N/T | -ve | N/T |
| TNH000515 | WW/L/SS/P/HO/LG | 15 | N/A | 97 | 97 | 84-104 | 96 | 89 | 95 | Fair | N/A | N/A | N/A | 95[0] | N/T | N/T | +ve | N/T |
| HRK000085 | WW/L/VA/U/MO/MG | 5 | N/A | 91 | 92 | 68-99 | 89 | 89 | 89 | Fair | N/A | N/A | N/A | 89[0] | 0.006 | 0.013 | +ve | Yes |

Notes: ( ) = affected by headwater erosion events; [+/-] = median score ecologically significant deviation from predicted scores; Trend significant/not significant at p<0.05; N/A = non-ringplain sites; N/A[s] = soft-bedded sites
3 =TRC generic health categories (Table 1), 4 = TRC predictive ringplain health categories (Table 2); = not trended (insufficient data at present).