Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2017-2018

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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 1995-1996 monitoring year. The macroinvertebrate component (insects and crustacea) was separated from the microfloral component (periphyton and cyanobacteria) in the 2002-2003 year. The latter programme was broadened to incorporate recently-developed techniques and is reported separately.

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

This report covers the 2017-2018 monitoring year. Biological surveys were performed in spring (October to December 2017) and summer (February to April 2018). Each seasonal survey assessed the macroinvertebrate communities at 59 sites in 26 rivers and streams. Two new sites were added in the 2015-2016 year, in the upper Waitara River and in the lower Whenuakura River, because of the need for the Council put in place adequate representative monitoring of the region's proposed Freshwater Management Units (as required by the National Policy Statement on Fresh Water).

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

For sites located in lower reaches of catchments the proportion of 'sensitive' taxa in the macroinvertebrate communities generally have been lower in summer than in spring, coincident with lower flows, higher water temperatures, less scouring, and increased smothering of habitats by more widespread algal growth within rivers and streams in summer. In 2017-2018 the median spring MCI score (105 units) was eight units higher than the median summer score (97 units), with the mean (average) spring score also eight units higher. The seasonal difference in scores was statistically significant. The spring median score was only one unit higher than the historical spring median while the summer median was four units lower. The greater than usual seasonal difference was likely due to the drought experienced in the Taranaki Region during the summer 2018 survey.

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

A moderate number of sites (seven sites) recorded new historical maximum MCI scores, while one site recorded a decrease in historical minimum score in the 2017-2018 period. One of the seven new maximum records was from the two sites established in the 2015-2016 period and hence was of little comparative significance.

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

The trends through time have been evaluated and will continue to be assessed on an annual basis as the SEM programme continues. Taking into account the full historical record for each site, there were 57 sites with trend data (based on the complete monitoring record of a minimum of more than 10 years' monitoring data).

Forty-eight sites had positive trends, with 27 of those sites having statistically significant improvements (after application of FDR tests[1]), all but two of which have also been of ecological importance. That is, not only is there confidence that the observed trends are real, but the degree of change that has occurred in the state of the in-stream communities is substantial. Only nine sites had negative trends and none of these was statistically significant. Three of the sites with negative trends were adversely affected by natural headwater erosion inside the National Park.

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

For the most recent ten-year data set, there were no sites that had a significant trend once FDR adjustment was applied. Prior to FDR adjustment being applied, two sites showed a significant improvement and five sites showed a significant decline. This may be due to several factors. Trends have plateaued recently at some sites, which may have been the result of riparian management initiatives having largely been

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

completed in some catchments, or the effects of point source discharge removal having subsequently stabilised. In addition, the smaller dataset has less power to support the assessment of differences being statistically significant within a background of natural fluctuations, even if real ecological improvements are occurring. Drought conditions in summer 2018 would have influenced results.

The recommendations for the 2018-2019 monitoring year provide for the freshwater biological component of the SEM monitoring to be maintained by way of the same macroinvertebrate faunal programme and for time trend reporting on the full data set and the most recent ten-year dataset (to detect recent trends) to be performed annually.

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1 Introduction

1.1 General

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

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

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

Annual SEM reports act as 'building blocks' towards the preparation of the regional state of the environment report every five years. 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 report (for the period 1995-2000) was published in 2003 (TRC, 2003). Data spanning the ten-year period 1995 to 2005 have been used in the preparation of a trend report (TRC, 2006). The third State of the Environment report (for the period 1995 to 2007) was published (TRC, 2009a) and included trend reporting and the fourth report (for the 1995 to 2014 period) has been published (TRC, 2015a). The provision of appropriate computer software statistical procedures allows regular reporting on trends in the environmental quality over time, in relation to Council's ongoing monitoring activities, now that there has been an accumulation of a comprehensive dataset of sufficient duration to permit a meaningful analysis of trends (i.e. minimum of 10 years).

This report summarises the results for the sites surveyed in the freshwater macroinvertebrate SEM programme over the 2017-2018 monitoring year, the twenty-third year of this programme.

1.2 Background

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

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

[2] Cawthron Institute Report 3073

2 Monitoring methodology

2.1 Programme design

The Council commenced the freshwater biological SEM programme in spring 1995. The 2017-2018 monitoring year was therefore the twenty-third year in which this SEM programme was undertaken. This report presents the results from the sites surveyed in the 2017-2018 monitoring year. The methodology for the programme is fully described in TRC (1997b) and summarised below.

2.1.1 Site locations

All sites in the freshwater biological SEM programme for the Taranaki region are illustrated in Figure 1 and described in Table 1. The biological programme for the 2017-2018 period involved the continuation of a riparian vegetation monitoring component incorporating five sites in the Kaupokonui River (see Table 1) 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 once the initial documentation of the effects and recovery was established. This river continued to be affected by headwater erosion in more recent years. Therefore, the programme was reviewed in 2006 and the Waiaua River excluded from the SEM programme. The Kurapete Stream (upstream and 5.5km downstream of the Inglewood oxidation pond system) has been monitored throughout the SEM period, using the appropriate SEM protocols, and has been included in the programme. Two additional sites in the Waiwhakaiho River catchment were included in 2002-2003 in recognition of the importance of this major catchment. A further two additional eastern hill country sites in the Whenuakura and Waitara Rivers were added to the programme in 2015-2016 to improve the representativeness of the monitoring programme, particularly in the light of the requirement of the National Policy Statement on Fresh Water that the Council undertakes representative monitoring across all Freshwater Management Units (FMUs) within the region. The Council has identified prospective FMUs and has adjusted its monitoring programmes in anticipation of these being confirmed in due course within the forthcoming *Regional Water and Land Plan* (in prep).

Table 1 Freshwater biological monitoring sites in the State of the Environment Monitoring programme

River/stream	Site	Site code	GPS location		Spring date	Summer date
			E	N		
Hangatahua (Stony) R	Mangatete Road	STY000300	1677460	5657823	30-Oct-17	28-Feb-18
Hangatahua (Stony) R	SH45	STY000400	1674632	5661558	30-Oct-17	28-Feb-18
Herekawe S	Centennial Drive	HRK000085	1688283	5674972	24-Oct-17	8-Feb-18
Huatoki S	Hadley Drive	HTK000350	1693349	5671486	24-Oct-17	8-Feb-18
Huatoki S	Huatoki Domain	HTK000425	1693041	5673404	24-Oct-17	8-Feb-18
Huatoki S	Molesworth St	HTK000745	1692800	5676424	24-Oct-17	8-Feb-18
Kapoaiaia S	Wiremu Road	KPA000250	1678009	5652025	31-Oct-17	5-Mar-18
Kapoaiaia S	Wataroa Road	KPA000700	1672739	5652272	31-Oct-17	5-Mar-18
Kapoaiaia S	Cape Egmont	KPA000950	1665690	5652452	31-Oct-17	5-Mar-18
Katikara S	Carrington Road	KTK000150	1683566	5657855	24-Oct-17	5-Mar-18
Katikara S	Beach	KTK000248	1676597	5667473	24-Oct-17	5-Mar-18
Kaupokonui R	Opunake Road	KPK000250	1698088	5639231	31-Oct-17	1-Mar-18
Kaupokonui R	U/s Kaponga oxi ponds	KPK000500	1698609	5634423	31-Oct-17	1-Mar-18
Kaupokonui R	U/s Lactose Co.	KPK000660	1697613	5629791	31-Oct-17	1-Mar-18
Kaupokonui R	Upper Glenn Road	KPK000880	1693026	5622705	31-Oct-17	1-Mar-18
Kaupokonui R	Near mouth	KPK000990	1691209	5620444	31-Oct-17	1-Mar-18
Kurapete S	U/s Inglewood WWTP	KRP000300	1705087	5665510	26-Oct-17	6-Mar-18
Kurapete S	D/s Inglewood WWTP	KRP000660	1709239	5667481	26-Oct-17	6-Mar-18
Maketawa S	Opp Derby Road	MKW000200	1702192	5656304	25-Oct-17	6-Mar-18
Maketawa S	Tarata Road	MKW000300	1708784	5665231	25-Oct-17	6-Mar-18
Mangaehu R	Raupuha Rd	MGH000950	1726300	5639062	9-Oct-17	15-Feb-18
Manganui R	SH3	MGN000195	1708871	5651282	25-Oct-17	6-Mar-18
Manganui R	Bristol Road	MGN000427	1711210	5667887	25-Oct-17	6-Mar-18
Mangaoraka S	Corbett Road	MRK000420	1702538	5676320	25-Oct-17	28-Feb-18
Mangati S	D/s railway line	MGT000488	1700095	5678043	26-Oct-17	28-Feb-18
Mangati S	Te Rima Pl, Bell Block	MGT000520	1699385	5679103	26-Oct-17	28-Feb-18
Mangawhero S	U/s Eltham WWTP	MWH000380	1712475	5633431	6-Nov-17	21-Mar-18
Mangawhero S	D/s Mangawharawhara S	MWH000490	1710795	5632738	6-Nov-17	21-Mar-18
Mangorei S	SH3	MGE000970	1696094	5671500	25-Oct-17	2-Mar-18
Patea R	Barclay Rd	PAT000200	1702620	5646598	30-Oct-17	3-Apr-18
Patea R	Swansea Rd	PAT000315	1711801	5644382	30-Oct-17	3-Apr-18
Patea R	Skinner Rd	PAT000360	1715919	5644681	30-Oct-17	3-Apr-18
Punehu S	Wiremu Rd	PNH000200	1687323	5637020	19-Oct-17	14-Feb-18
Punehu S	SH45	PNH000900	1677946	5627786	19-Oct-17	14-Feb-18
Tangahoe R	Upper Valley	TNH000090	1725340	5626101	1-Nov-17	16-Feb-18
Tangahoe R	Tangahoe Vly Rd bridge	TNH000200	1719126	5622681	1-Nov-17	16-Feb-18
Tangahoe R	d/s rail bridge	TNH000515	1715751	5612470	1-Nov-17	16-Feb-18
Timaru S	Carrington Road	TMR000150	1684423	5659634	30-Oct-17	28-Feb-18
Timaru S	SH45	TMR000375	1679509	5665554	30-Oct-17	28-Feb-18
Waiau S	Inland North Road	WAI000110	1714587	5680018	25-Oct-17	28-Feb-18
Waimoku S	Lucy's Gully	WMK000100	1681324	5666240	30-Oct-17	28-Feb-18
Waimoku S	Beach	WMK000298	1681725	5669851	30-Oct-17	28-Feb-18

River/stream	Site	Site code	GPS location		Spring date	Summer date
			E	N		
Waingongoro R	700m d/s Nat Park	WGG000115	1700835	5645086	6-Nov-17	21-Mar-18
Waingongoro R	Opunake Rd	WGG000150	1705692	5642523	6-Nov-17	21-Mar-18
Waingongoro R	Eltham Rd	WGG000500	1710576	5634824	6-Nov-17	21-Mar-18
Waingongoro R	Stuart Rd	WGG000665	1709784	5632049	6-Nov-17	21-Mar-18
Waingongoro R	SH45	WGG000895	1704042	5618667	6-Nov-17	21-Mar-18
Waingongoro R	Ohawe Beach	WGG000995	1702531	5617624	6-Nov-17	21-Mar-18
Waiokura S	Skeet Rd	WKR000500	1698807	5628892	31-Oct-17	1-Mar-17
Waiokura S	Manaia Golf Course	WKR000700	1697636	5622019	31-Oct-17	1-Mar-17
Waiongana S	SH3a	WGA000260	1705159	5669554	24-Oct-17	19-Feb-18
Waiongana S	Devon Road	WGA000450	1704063	5680381	24-Oct-17	19-Feb-18
Waitara R	Autawa Road	WTR000540	1720719	5663669	20-Oct-17	9-Feb-18
Waitara R	Mamaku Road	WTR000850	1708384	5678739	20-Oct-17	9-Feb-18
Waiwhakaiho R	National Park	WKH000100	1696096	5658351	25-Oct-17	2-Mar-18
Waiwhakaiho R	SH3 (Egmont Village)	WKH000500	1698297	5666893	25-Oct-17	2-Mar-18
Waiwhakaiho R	Constance St (NP)	WKH000920	1695827	2677271	25-Oct-17	2-Mar-18
Waiwhakaiho R	Adjacent to L Rotomanu	WKH000950	1696587	2678336	25-Oct-17	2-Mar-18
Whenuakura R	Nicholson Rd	WNR000450	1732757	5598479	1-Nov-17	16-Feb-18

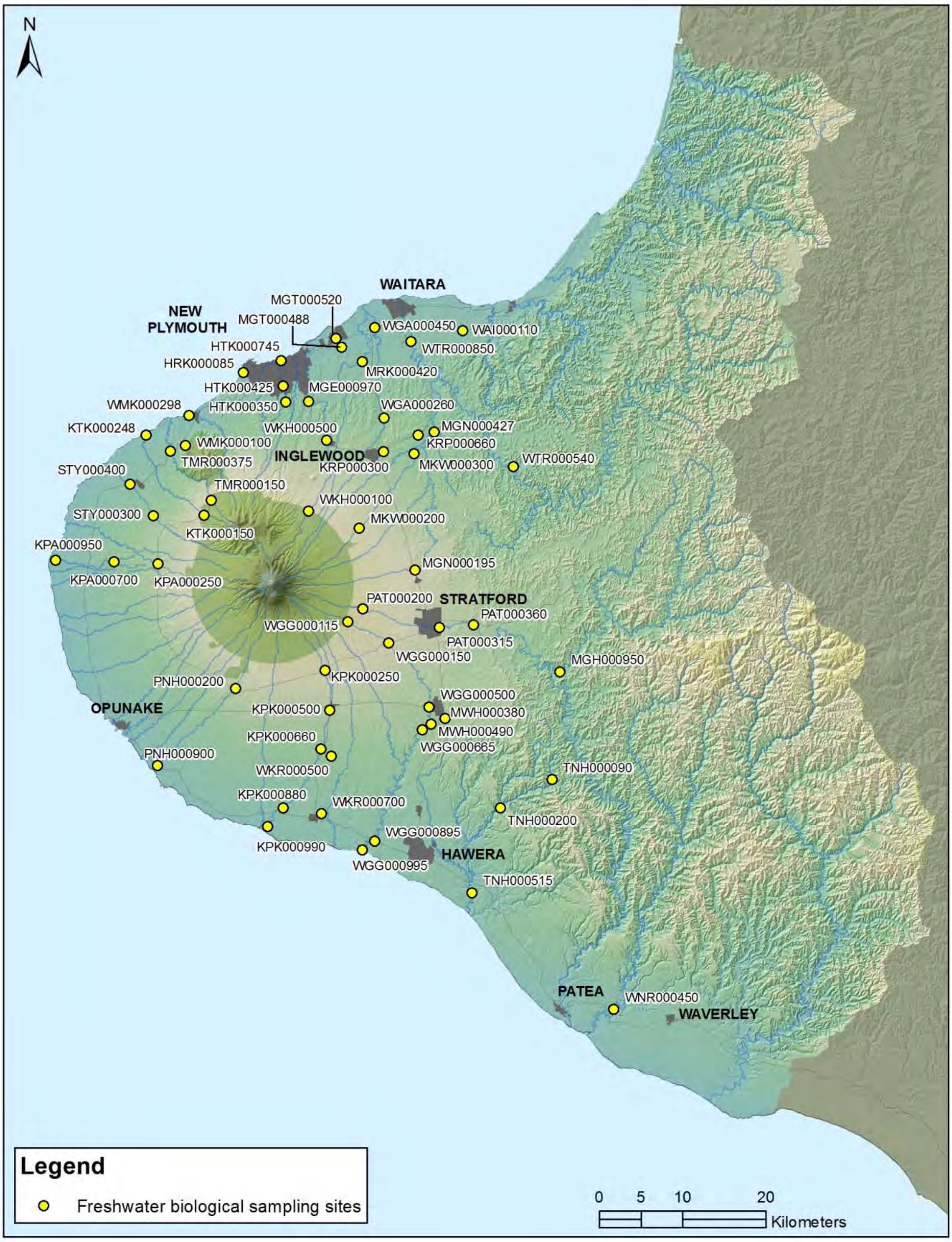


Figure 1 Location of macroinvertebrate fauna sampling sites for the 2017-2018 SEM programme

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

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

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

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

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

The Waiwhakaiho River and its headwater tributaries arise above the tree line on the north face of Mount Taranaki. Upon leaving the National Park, the river flows north through agricultural and industrial land for 27 kilometres to the sea. The river passes under State Highway 3 near Egmont Village, nine kilometres downstream of the National Park boundary. The sites at Constance Street and adjacent to Lake Rotomanu are included in the lower Waiwhakaiho River industrial discharges monitoring programme. The site adjacent to Lake Rotomanu has replaced the site immediately downstream of the Mangaone Stream that was used in the 1995-1996 State of the Environment monitoring survey. This allows the State of the Environment monitoring programme to better integrate with the industrial monitoring programme. The Mangorei Stream is the principal tributary catchment in the lower reaches, downstream of the major abstraction of water for hydroelectric and community supply purposes. Occasional headwater erosion events have been documented in the upper river with an instance of severe (orange) discolouration in spring 2014 due to release of naturally occurring iron oxide from a small headwater tributary.

The source of the Manganui River is situated above the tree line on the eastern slopes of Mount Taranaki. After leaving the National Park, the river flows east and then north through agricultural land for 44 kilometres before joining the Waitara River. State Highway 3 is eight kilometres downstream of the National

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

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

The Waitara River flows south-west and then north-west out of the eastern hill country through a mix of agricultural land and native forest before passing through the town of Waitara and out to sea. It has a different character from the steep ring plain rivers and carries a high silt load. The Autawa Road site is located 46 km from the coast. This site was added only during the 2015-2016 reporting period, to increase the number of eastern hill country sites being monitored. The Mamaku Road site is located six km upstream of the coast above any tidal influence. This site is also part of the monitoring programme for the stormwater discharge from the Waitara Valley Methanex plant to the Waitara River.

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

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

The Whenuakura River is an eastern hill country river which primarily flows through agricultural land. It has a high silt load and is consequently highly turbid. The only site located on the Whenuakura River was at Nicholson Road. This was included from 2015-2016 onwards to increase the number of eastern hill country rivers being monitored.

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

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

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

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

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

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

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

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

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

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

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

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

2.1.2 Trend analysis

State of the environment (SEM) macroinvertebrate data collected at SEM sites in the region over the twenty-three year (1995-2018) and last ten-year (2008-2018) periods under standard TRC programme protocols were analysed for trends over time. The MCI, a surrogate for stream health, was selected as the most appropriate index for use in the assessment of time trends (see Stark and Maxted, 2007).

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

MCI data was then statistically analysed for trends over time using the Mann-Kendall test followed by false discovery rate (FDR) analysis for sites with a minimum of ten-years continuous data recorded (Stark and Fowles, 2006). The significance of a site's trend (i.e. the strength of the trend) was calculated according to the statistical probability of occurrence (p-value), as long as similar numbers of samples were collected for analysis, which has been the case with the TRC programme. A Kendall tau coefficient was also produced which indicated whether the trend was positive or negative and the magnitude of the trend.

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

To place these trends in perspective, each site may be assessed against graduations (bands of MCI values) of stream health. In this instance, Stark's (1985) categories have been refined (using BPJ) as illustrated in Table 3 in Section 2.2.1.2 below (Stark & Fowles, 2015).

2.2 Sample collection and analysis

The standard '400 ml kick-sampling' and rarely the '400 ml sweep-net- sampling' techniques were used to collect streambed (benthic) macroinvertebrates from various sampling sites in selected catchments in the Taranaki region (detailed in section 2.4 and TRC, 1997b). The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) and the 'sweep-net- sampling' technique is very similar to Protocol C2 of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001). Surveys of all sites are normally performed twice during the monitoring year, once during spring (October to December) and once during summer (February and March). An audit of the macroinvertebrate samples used for SEM purposes was undertaken this monitoring year, as it had been noted that some surveys in the database did not appear to be for SEM purposes. A very small number of surveys were found to be wrongly assigned as SEM surveys and have since been removed from the analysis. Further information outlinng this can be found at TRC, 2019. Sampling dates for each site are detailed in Table 1.

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). Macroinvertebrate taxa were placed in abundance categories for each sample (Table 2).

Table 2 Macroinvertebrate abundance categories

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

2.2.1 Environmental parameters and indicators

2.2.1.1 Taxonomic richness

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

2.2.1.2 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. Communities that are more 'sensitive' inhabit less polluted waterways.

A refinement of Stark's classification (Stark, 1985, Boothroyd and Stark, 2000; and Stark and Maxted, 2007) has been made in order to grade the biological 'health' based upon MCI and SQMCI ranges. This gradation is presented in Table 3.

Table 3 Generic MCI gradation of biological water quality conditions adapted for Taranaki streams and rivers

TRC Grading	MCI	SQMCI	Colour Code	Stark's classification
Excellent	≥140	≥7.00		Excellent
Very Good	120-139	6.00-6.99		
Good	100-119	5.00-5.99		Good
Fair	80-99	4.00-4.99		Fair
Poor	60-79	3.00-3.99		Poor
Very Poor	<60	<3.00		

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

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

2.2.1.2.1 Predictive measures using the MCI

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

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

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

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

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

2.2.1.3 Semi Quantitative MCI (SQMCI)

A semi-quantitative MCI value (SQMCI) (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 is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of more than 0.83 units is considered statistically significant. However, Stark and Maxted (2007) considered the MCI to be a more appropriate index than the SQMCI for State of the Environment monitoring and discussion, and in this report emphasis will be placed on the MCI.

3 Results and discussion

3.1 Flows

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

Hydrological flow recorders continuously monitor water levels in the Mangaoraka, Waiongana, Punehu, and Kapoaiaia, WaiokurStreams, and the Waiwhakaiho, Manganui, Patea, Mangaehu, Waingongoro, Kaupokonui, Waitara, and Whenuakura Rivers. The proximity of previous freshes (elevated flows) for each site surveyed, are summarised in Table 4, with flow assessments extrapolated from nearby catchments for sites where flow recorders did not exist.

Table 4 Duration since freshes at sampling sites in the 2017-2018 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	(16)	(17)	(22)	(26)
Hangatahua (Stony) R	SH45	(16)	(17)	(22)	(26)
Herekawe S	Centennial Drive	(10)	(11)	(34)	(92)
Huatoki S	Hadley Drive	(10)	(11)	(11)	(13)
Huatoki S	Huatoki Domain	(10)	(11)	(11)	(13)
Huatoki S	Molesworth St	(10)	(11)	(19)	(19)
Kapoaiaia S	Wiremu Road	16	16	28	28
Kapoaiaia S	Wataroa Road	16	16	28	28
Kapoaiaia S	Near coast	16	16	28	28
Katikara S	Carrington Road	(10)	(11)	(9)	(13)
Katikara S	Near mouth	(10)	(11)	(9)	(13)
Kaupokonui R	Opunake Rd	19	20	8	28
Kaupokonui R	U/s Kaponga oxi ponds	19	20	8	28
Kaupokonui R	U/s Lactose Co.	19	20	8	28
Kaupokonui R	Glenn Rd	19	20	8	28
Kaupokonui R	Beach	19	20	8	28
Kurapete S	U/s Inglewood WWTP	(12)	(13)	(14)	(118)
Kurapete S	6 km d/s Inglewood WWTP	(12)	(13)	(14)	(118)
Maketawa S	Opp Derby Road	(12)	(12)	(28)	(28)
Maketawa S	Tarata Road	(12)	(12)	(28)	(28)
Mangaehu R	Raupuha Road	11	12	16	16
Manganui R	SH3	7	12	19	20
Manganui R	Bristol Road	7	12	19	20
Mangaoraka S	Corbett Road	(11)	(12)	7	42
Mangati S	D/s railway line	(12)	(13)	(8)	(112)
Mangati S	Te Rima Pl, Bell Block	(12)	(13)	(8)	(112)
Mangawhero S	U/s Eltham WWT Plant	(25)	(67)	(12)	(204)
Mangawhero S	D/s Mangawharawhara S	(25)	(67)	(12)	(204)
Mangorei S	SH3	(11)	(11)	(10)	(10)

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
Patea R	Barclay Rd	19	21	9	26
Patea R	Swansea Rd	19	21	9	26
Patea R	Skinner Rd	19	21	9	26
Punehu S	Wiremu Rd	8	10	32	33
Punehu S	SH45	8	10	32	33
Tangahoe R	Upper Valley	(19)	(20)	(7)	(29)
Tangahoe R	Tangahoe Valley Road	(19)	(20)	(7)	(29)
Tangahoe R	D/s railbridge	(19)	(20)	(7)	(29)
Timaru S	Carrington Road	(16)	(17)	(11)	(11)
Timaru S	SH45	(16)	(17)	(11)	(11)
Waiau S	Inland North Road	(11)	(12)	(10)	(12)
Waimoku S	Lucy's Gully	(16)	(17)	(11)	(11)
Waimoku S	Beach	(16)	(17)	(11)	(11)
Waingongoro R	900m d/s Nat Park	26	29	11	13
Waingongoro R	Opunake Rd	26	29	11	13
Waingongoro R	Eltham Rd	26	29	11	13
Waingongoro R	Stuart Rd	26	29	11	13
Waingongoro R	SH45	16	30	23	90
Waingongoro R	Ohawe Beach	14	26	12	12
Waiokura S	Skeet Road	(73)	(74)	112	140
Waiokura S	Manaia Golf-Course	(73)	(74)	112	140
Waiongana S	SH3a	10	11	11	12
Waiongana S	Devon Road	10	11	11	12
Waitara	Autawa Road	21	22	9	10
Waitara	Mamaku Road	11	23	10	10
Waiwhakaiho R	National Park	11	12	8	10
Waiwhakaiho R	SH3 (Egmont Village)	11	12	8	10
Waiwhakaiho R	Constance St (NP)	11	12	8	10
Waiwhakaiho R	Adjacent Lake Rotomanu	11	12	8	10
Whenuakura R	Nicholson Road	19	20	7	29

NB: ( ) = extrapolation from nearby catchment

Flow protocols prevent sampling within seven days after a 3x median fresh or ten days after a 7x median fresh, as higher flows disturb community composition and abundance. Spring surveys were performed 7 to 74 days after a moderate fresh (> 3x median flow). The summer 2018 surveys were performed 7-204 days after a moderate fresh.

3.2 Macroinvertebrate communities

Lists of the taxa found during spring 2017 and summer 2018 surveys, together with taxa richness, MCI scores and other appropriate indices for each site are tabulated and attached as Appendix I. These results are discussed below on a stream by stream basis for the sites and seasons (spring and summer) in which the surveys were conducted. Data from previous surveys are also presented for each site and results to date are illustrated as appropriate.

3.2.1 Hangatahua (Stony) River

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

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

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

3.2.1.1 Mangatete Road site (STY000300)

3.2.1.1.1 Taxa richness and MCI

Forty-three SEM surveys have been undertaken in the Stony River at this mid-reach site between October 1995 and March 2017. These results are summarised in Table 5, together with results from the current period, and illustrated in Figure 2.

Table 5 Results from SEM surveys performed in the Stony River at Mangatete Road together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
STY000400	43	1-21	10	64-160	112	8	110	5	104

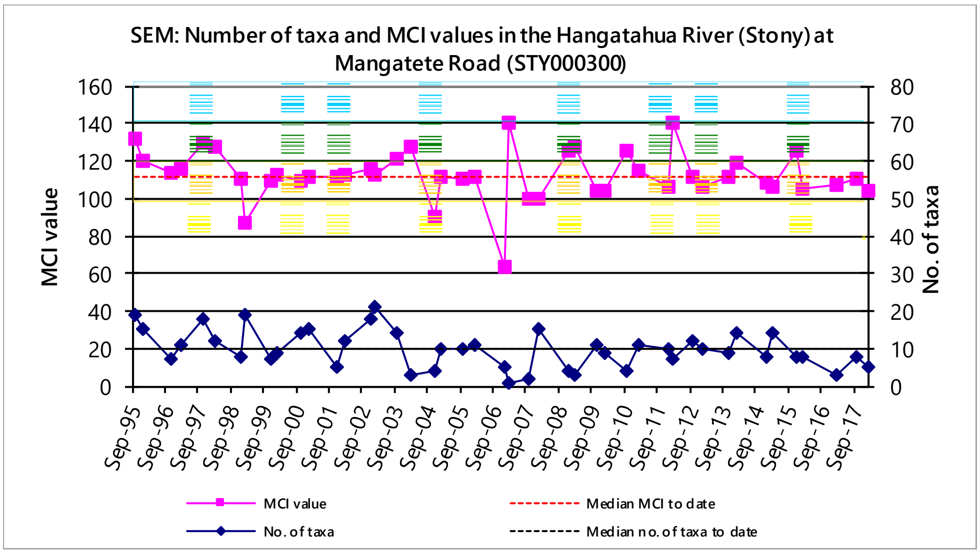


Figure 2 Numbers of taxa and MCI values in the Hangatahua (Stony) River at Mangatete Road

A wide range of richness (1 to 21 taxa) has been recorded as a consequence of extensive headwater erosion impacts on the river's communities with a median richness of only 10 taxa, far fewer than might be expected for a ringplain river site at this altitude (160 masl). In the 2017-2018 period, richness was much lower than the median, indicative of continuing erosion impacts of scouring, finer sediment deposition, and bed movement.

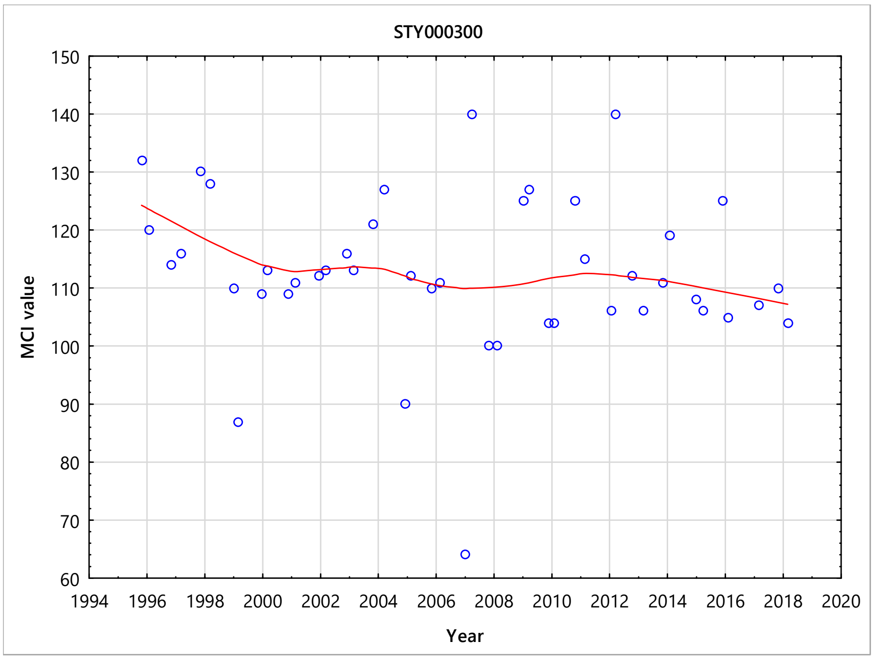
There are significant limitations when using the MCI for community compositions affected by sedimentation and erosion events (e.g. scores show considerable significant variability when relatively few taxa are present). Values at this site have ranged widely between 64 and 160 units with a median MCI value of 112 units. The spring and summer scores were a non-significant three and nine units lower than the historical median. The summer score categorised this site as having 'good' health (Table 3). The historical median score (112 units) placed this site's river health in the 'good' category. The paucity of the communities in terms of richness in particular must be taken into account at the site, where headwater erosion effects have been very pronounced and the substrate remains relatively mobile and well scoured.

3.2.1.1.2 Predicted river 'health'

The Stony River at Mangatete Road is 7.3 km downstream of the National Park boundary at an altitude of 160 masl. A relationship for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 109 for this site. The historical site median (112 units) was not significantly different (Stark and Fowles, 2009) to the predictive value. The spring 2017 and summer 2018 survey scores were also not significantly different to the predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 128 units. The historical site median and the scores recorded in the year under review were both significantly lower than this value.

3.2.1.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced for the full dataset (Figure 3). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Stony River at Mangatete Road.



N = 45
Kendall tau = - 0.180
p level = 0.081
FDR p = 0.130

N = 19
Kendall tau = -0.228
p level = 0.172
FDR p = 0.460

Figure 3 LOWESS trend plot of MCI data at Mangatete Road site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

Although a decreasing trend in MCI scores has been found for the full dataset, particularly over the first six years, this has not been statistically significant. The trendline at this site has a range of MCI scores of about 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, the trendline shows 'good' generic river 'health'; deteriorating slightly from 'very good' (prior to 1997). However, the majority of the variability was caused by severe headwater erosion events at varying intervals over the period.

A slight negative trend in MCI scores has been found at this site for the ten-year dataset. However, this has not been statistically significant. Overall, the ten-year trendline shows 'good' generic river 'health'.

3.2.1.2 SH 45 site (STY000400)

3.2.1.2.1 Taxa richness and MCI

Forty-three surveys have been undertaken in the Stony River at this lower reach site between October 1995 and March 2017. These results are summarised in Table 6, together with results from the current period, and illustrated in Figure 4.

Table 6 Results from SEM surveys performed in the Stony River at SH 45 together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
STY000400	43	0-18	9	0-160	108	11	100	12	105

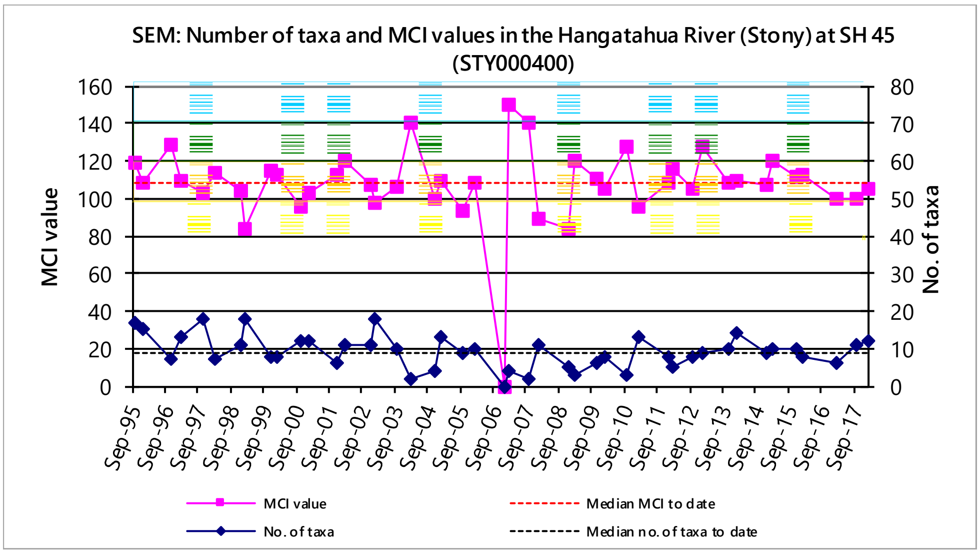


Figure 4 Numbers of taxa and MCI values in the Hangatahua (Stony) River at SH 45

A wide range of richness (0 to 18 taxa) has been recorded mainly as a consequence of extensive headwater erosion impacts on the river's communities, with a median richness of only nine taxa, far fewer than would be expected for a ringplain river site at this altitude (70 m asl) [e.g. median of 18 taxa (TRC, 2017b)]. In the 2017-2018 period richness was moderately low with only eleven and twelve taxa recorded in spring and summer respectively. These scores were two and three taxa higher than the site's historical median, indicative of continuing erosion impacts of scouring, finer sediment deposition, and bed movement at this site.

There are significant limitations when using the MCI for community compositions affected by sedimentation and erosion events (e.g. scores show considerable variability when relatively few taxa are present). Values at this site have ranged widely between 0 and 160 units with a median MCI value of 109 units. The MCI scores for the spring 2017 survey (100 units) and summer 2018 survey (105 units) were non-significant nine and four units lower than the historical median respectively (Figure 4). The score categorised this site as having 'good' health (Table 3). However, the paucity of numbers and richness should be recognised in this assessment given the historical impacts of headwater erosion effects along the length of the river channel and the persistently high rainfall that occurred preceding this survey.

3.2.1.2.2 Predicted river 'health'

The Stony River at SH 45 is 12.5 km downstream of the National Park boundary at an altitude of 70 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict an MCI value of 103 for this site. The historical site median and summer score were both not significantly different (Stark, 1998) to the distance predictive value. The historical median and summer score was not significantly different to the REC predicted score (Leathwick, et al. 2009) of 115 units but the spring score was significantly lower.

3.2.1.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced using the full dataset (Figure 5). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Stony River at SH 45.

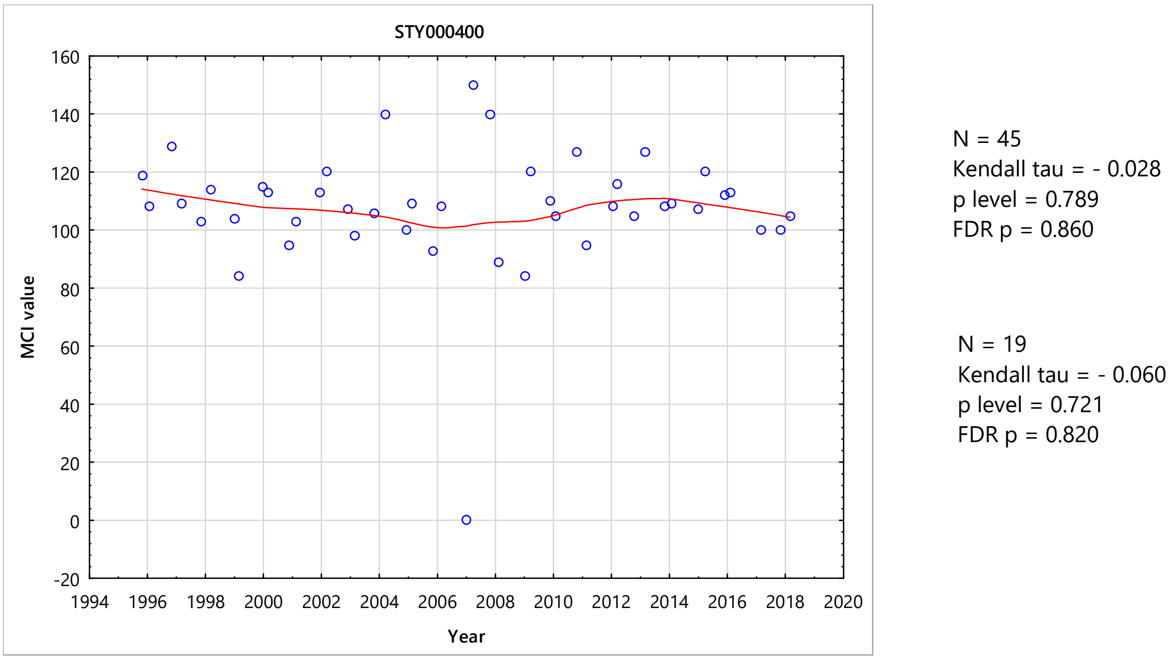


Figure 5 LOWESS trend plot of MCI data at SH 45 site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

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

There has been a minor negative trend in MCI scores over the ten-year period which was not statistically significant. Overall, the trend line shows 'good' generic river 'health'.

3.2.1.3 Discussion

Due to the major influence of historical 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 abundant or diverse as elsewhere in ringplain streams.

Taxa richness at both sites was typically low. This was likely due to erosion events and significant freshes preceding the survey impacting on the macroinvertebrate communities.

MCI scores indicted 'good' health for both sites which were not significantly different to historical medians. There was a non-significant decrease in MCI score at the downstream under spring conditions but not summer conditions indicating little change in macroinvertebrate health in a downstream direction.

3.2.2 Herekawe Stream

One site in this small lowland coastal ringplain stream on the western perimeter of New Plymouth City was incorporated into the SEM programme in 2008 for the purpose of monitoring a newly-developed walkway and associated riparian planting initiatives in the lower reaches of the stream. Consent monitoring also has been performed at this 'control' site in spring and summer throughout the period from 1995 to 2018 (and dates back to 1986).

The results found by the 2017-2018 surveys are presented in Table 72, Appendix I for this small lowland stream.

3.2.2.1 Centennial Drive site (HRK000085)

3.2.2.1.1 Taxa richness and MCI

Forty-three surveys have been undertaken in this lower-reach site in the Herekawe Stream between February 1995 and February 2017. These results are summarised in Table 7, together with the results from the current period, and illustrated in Figure 6.

Table 7 Results of previous surveys performed in Herekawe Stream at Centennial Drive, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HRK000085	43	13-29	19	68-100	89	21	83	20	85

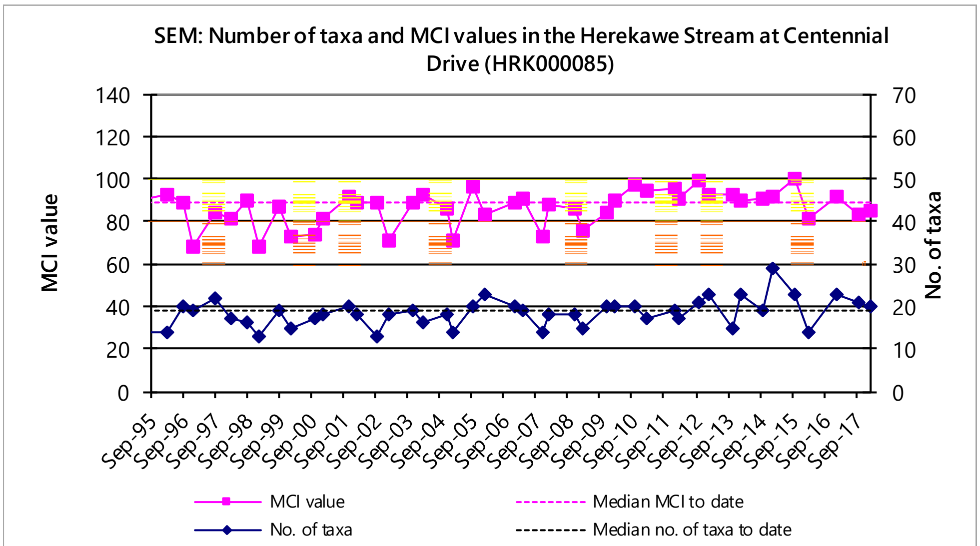


Figure 6 Numbers of taxa and MCI values in the Herekawe Stream upstream of Centennial Drive

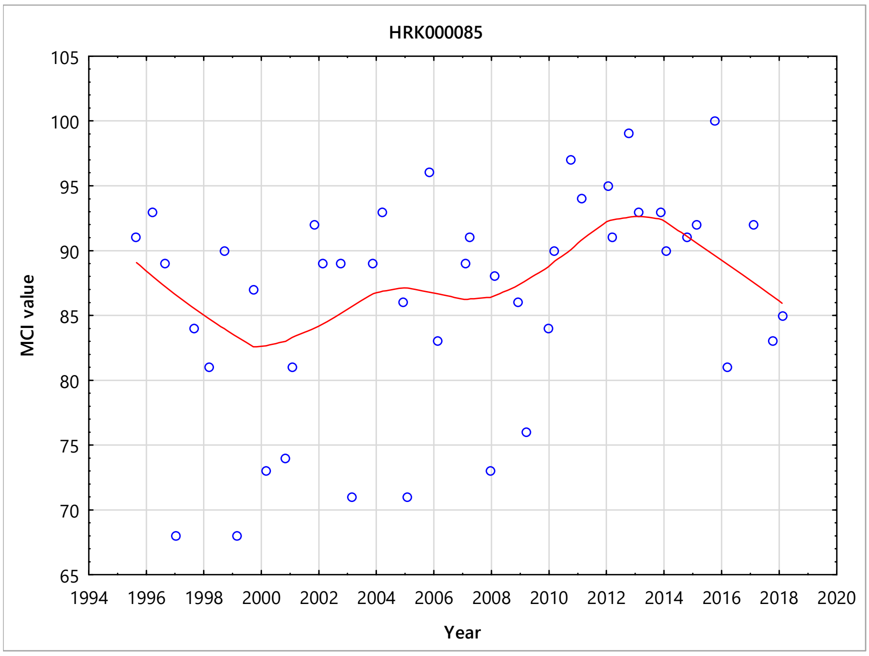
A moderate range of richness (13 to 29 taxa) had been found, with a median richness of 19 taxa which has been more representative of typical richness in small lowland coastal streams where a median richness of 17 taxa has been recorded from previous surveys of 'control' sites at similar altitudes (TRC, 2017b). During the 2017-2018 period, sping (21 taxa) and summer (20 taxa) richness were similar to the median richness for the site. MCI values have had a relatively wide range (31 units) at this site. The median value (89 units) is above scores typical of lower reach sites elsewhere in small lowland coastal streams. The spring 2017 (83 units) and summer 2018 (85 units) scores were not significantly different (Stark, 1998) to the historical median. These scores categorised this site as having ‘fair’ health generically (Table 3). The historical median score (89 units) placed this site in the ‘fair’ category.

3.2.2.1.2 Predicted stream ‘health’

The Herekawe Stream rises as seepage near the coast on the ringplain and the site at Centennial Drive, Omata is in the lower reaches near the mouth at an altitude of 5 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 89 units. The historical median, and sping and summer scores were not significantly different (Stark, 1998) to this value.

3.2.2.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 7). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from Herekawe Stream at Centennial Drive.



N = 45
Kendall tau = 0.240
p level = 0.020
FDR p = 0.040

N = 19
Kendall tau = -0.006
p level = 0.972
FDR p = 0.970

Figure 7 LOWESS trend plot of MCI data in the Herekawe Stream at the Centennial Drive site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

There was a positive significant trend in MCI scores for the full dataset 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 23-year period with a general trend of improvement since 2000 and particularly after 2008, with more recent stability, but with some wide variations in individual MCI scores. The trendline variation (10 units) suggested some ecologically important changes have occurred over the monitoring period. The trendline was indicative of ‘fair’ stream health.

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

3.2.2.2 Discussion

Spring and summer values are typically very similar at this site with seasonal median MCI values being identical over the 23-year period (Appendix II). The survey results were within expected parameters with the site having 'fair' health and not having any significant differences between the current score and median and predicted results.

3.2.3 Huatoki Stream

The Huatoki Stream is a small ringplain stream arising outside Egmont National Park that flows south to north with the middle and lower parts of the catchment in the New Plymouth city area. There are three SEM sites on the stream. The results of spring 2017 and summer 2018 surveys are summarised in Table 73 and Table 74, Appendix I.

3.2.3.1 Hadley Drive site (HTK000350)

3.2.3.1.1 Taxa richness and MCI

Forty-one surveys have been undertaken, between December 1996 and February 2017, at this lower mid-reach, unshaded site, draining open developed farmland, on the outskirts of New Plymouth city. These results are summarised in Table 8, together with the results from the current period, and illustrated in Figure 8.

Table 8 Results of previous surveys performed in the Huatoki Stream at Hadley Drive together with 2017-2018 results

Site code	SEM data (1996 to February 2018)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000350	41	22-34	26	79-115	96	19	113	21	97

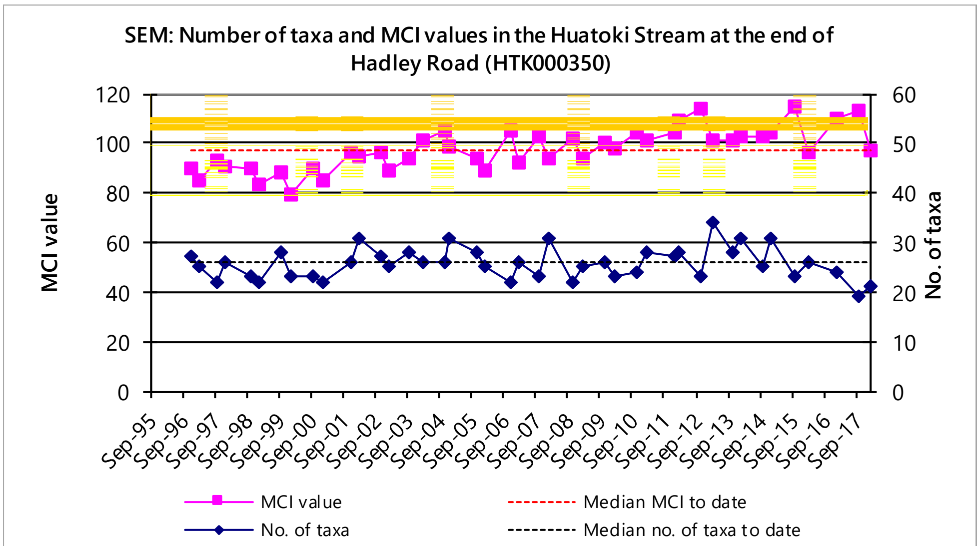


Figure 8 Numbers of taxa and MCI values in the Huatoki Stream at the end of Hadley Drive

A moderate range of richness (22 to 34 taxa) has been found with a relatively high median richness of 26 taxa, relatively typical of richness in the mid to lower reaches of ringplain streams rising outside of the National Park. During the 2017-2018 period spring (19 taxa) and summer (21 taxa) richness were relatively similar to the historical median richness.

MCI values have had a relatively wide range (36 units) at this site, typical of mid to lower reach sites on the ringplain. The spring 2017 (113 units) score was significantly higher (Stark, 1998) than the historical median by 17 units, while the summer 2018 (97 units) score was not significantly different to the historical median score. The spring and summer scores respectively categorised this site as having 'good' and 'fair' health generically (Table 3). The historical median score (96 units) placed this site in the 'fair' category for generic health.

3.2.3.1.2 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site at Hadley Drive is in the lower mid-reaches at an altitude of 60 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 95 units. The historical median and summer score was similar to this value and the spring score was significantly higher (Stark, 1998) by 20 units.

3.2.3.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 9). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1996-2018) and the most recent ten-years of results (2008-2018) from the site in the Huatoki Stream at Hadley Drive.

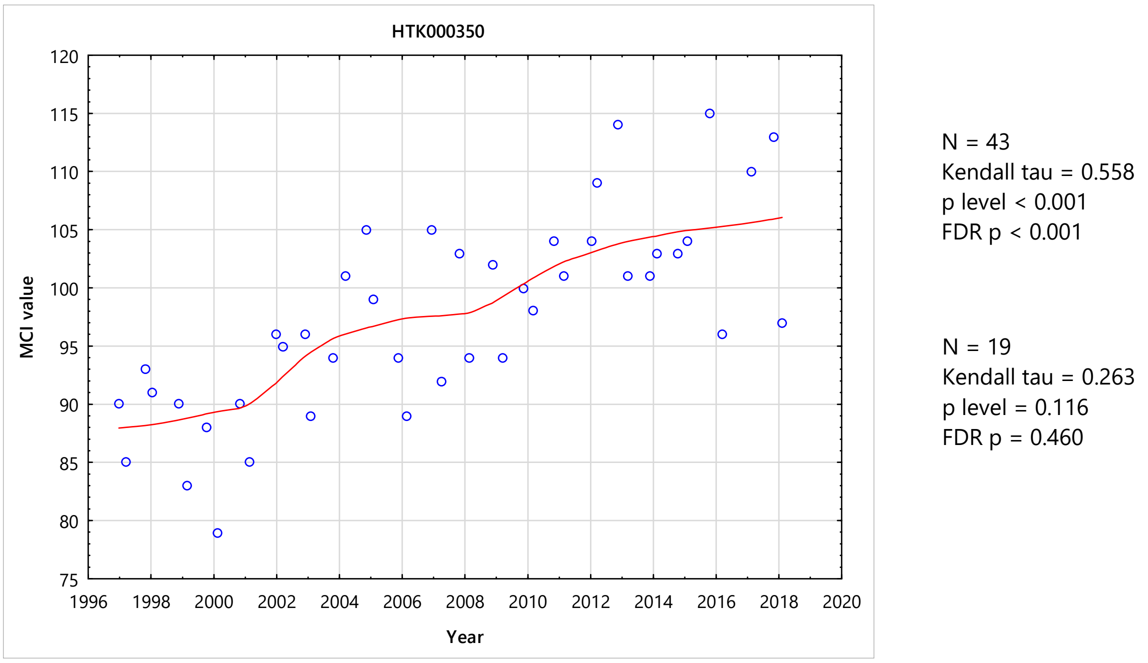


Figure 9 LOWESS trend plot of MCI data in the Huatoki Stream at the Hadley Drive site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A strong significant improvement ($p < 0.01$) in MCI scores, particularly since 2000 has been illustrated at this site on the outskirts of New Plymouth over the 23-year period. The wide range of MCI scores (18 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. MCI scores have been indicative of 'fair' generic stream health almost throughout the period improving to 'good' health since 2010.

A non-significant trend in MCI scores has been found over the ten-year period in contrast with the significant positive result found in the full dataset. The trendline was mostly indicative of 'good' health.

3.2.3.2 Huatoki Domain site (HTK000425)

3.2.3.2.1 Taxa richness and MCI

Forty-one surveys have been undertaken at this lower middle reach site in the Huatoki Stream toward the downstream boundary of the Huatoki Domain between December 1996 and February 2017. These results are summarised in Table 9, together with the results from the current period, and illustrated in Figure 10.

Table 9 Results of previous surveys performed at Huatoki Stream in Huatoki Domain, together with the 2017-2018 results

Site code	SEM data (1996 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000425	41	17-32	26	91-115	104	24	117	23	108

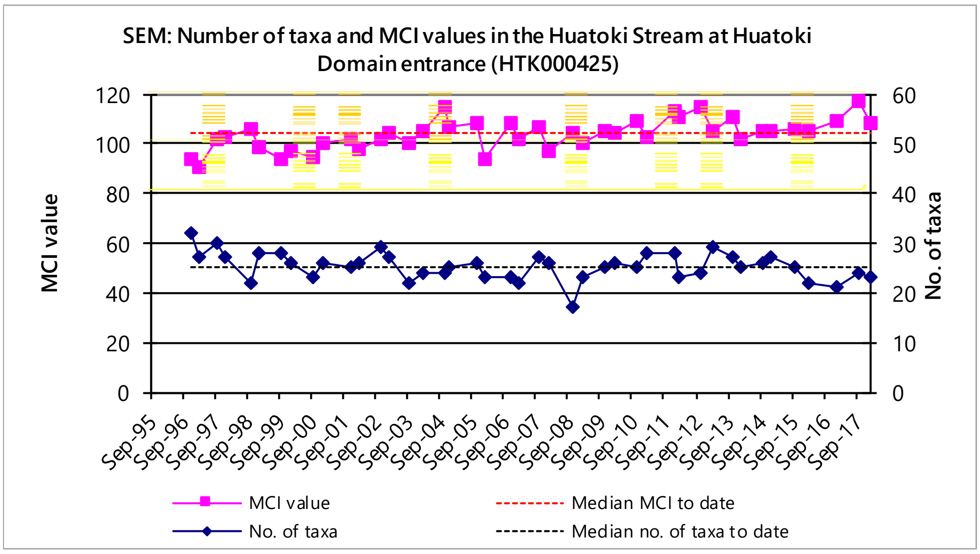


Figure 10 Numbers of taxa and MCI values in the Huatoki Stream at the Huatoki Domain

A moderate range of richness (17 to 32 taxa) has been found, with a median richness of 26 taxa (more representative of typical richness for the lower reaches of ringplain streams rising outside the National Park boundary). During the 2017-2018 period spring (24 taxa) and summer (23 taxa) richness were only slightly taxa lower than the historical median richness.

MCI values have had a moderately wide range (24 units) at this site. The median value (104 units) has been higher than typical of lower reach sites elsewhere on the ringplain however. The spring 2017 (117 units) score was a significant 13 units higher than the historical median (Stark 1998), while the summer 2018 (108 units) score was not significantly different to the historical median value. The spring and summer scores categorised this site as having 'good' health generically (Table 3). The historical median score (104 units) also placed this site in the 'good' category for generic health.

3.2.3.2.2 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site at Hadley Domain is in the lower mid-reaches at an altitude of 30 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical, spring and summer scores were all significantly higher than the REC value by 12 to 25 units (Stark, 1998).

3.2.3.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 11). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1996-2018) and the most recent ten-years of results (2008-2018) from the site in the Huatoki Stream at Huatoki Domain.

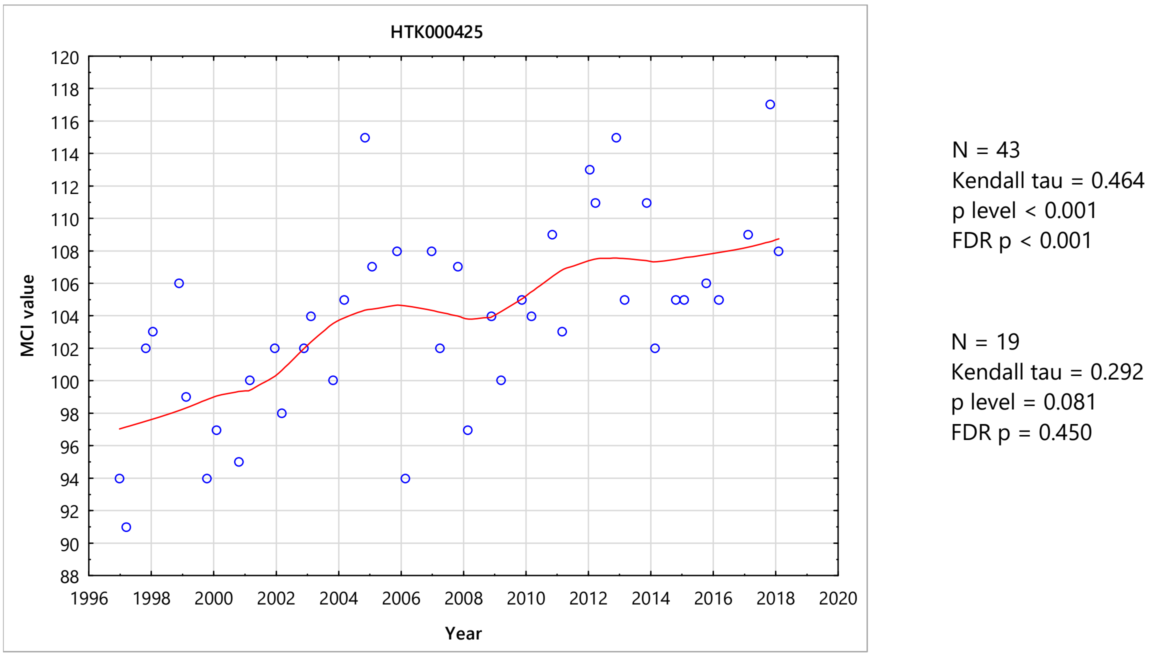


Figure 11 LOWESS trend plot of MCI data in the Huatoki Stream for the Huatoki Domain site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A similar temporal trend of a marked improvement in MCI scores, but not as strong as that found at the upstream site (at Hadley Drive), was identified at this site in the Domain although scores peaked with small decreases after 2006 and 2012. The overall trend has been very significant after FDR application ($p < 0.01$) and the trendline range of scores (12 units) although only of marginal ecological importance. The trend has probably been related to the upstream catchment activities noted above as no nearby habitat changes have been recorded within the Domain.

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

A non-significant trend in MCI scores has been found over the ten-year period in contrast with the significant positive result found in the full dataset. The trendline was indicative of 'good' health.

3.2.3.3 Site near coast (HTK000745)

3.2.3.3.1 Taxa richness and MCI

Forty-one surveys have been undertaken at this lower reach site in the Huatoki Stream between December 1996 and February 2017. These results are summarised in Table 10, together with the results from the current period, and illustrated in Figure 12.

Table 10 Results of previous surveys performed in Huatoki Stream at the site near the coast, together with the 2017-2018 results

Site code	SEM data (1996 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000745	41	14-27	22	69-101	86	17	102	11	75

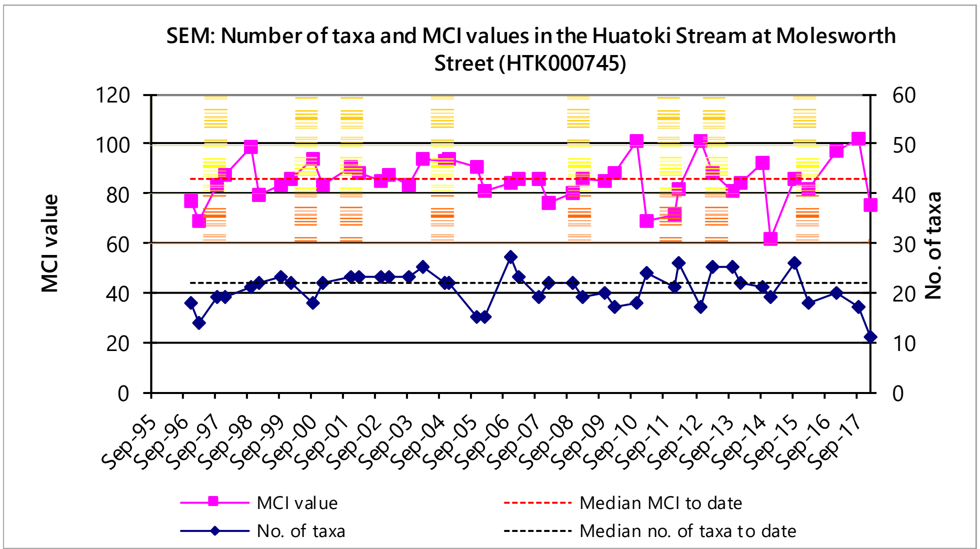


Figure 12 Numbers of taxa and MCI values in the Huatoki Stream at Molesworth Street (near coast)

A moderate range of richness (14 to 27 taxa) has been found, with a median richness of 22 taxa (more representative of typical richness in the lower reaches of ringplain streams rising outside the National Park boundary). During the 2017-2018 period spring (17 taxa) was five taxa less than hisotical median richness, while summer (11 taxa) richness was a substantial 11 taxa different from the historical median richness. The summer richness was also the the lowest richness recorded at this site to date, by three taxa.

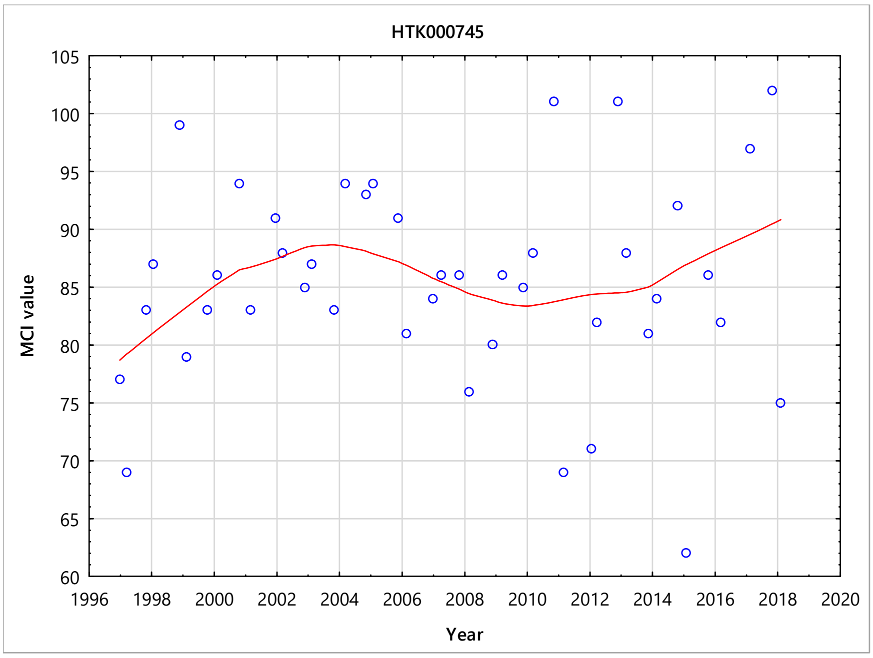
MCI values have had a relatively wide range (32 units) at this site. However, the median value (86 units) has been typical of lower reach sites elsewhere on the ringplain. The scores recorded in the 2017-2018 period showed substantial variation. The spring 2017 (102 units) score was significantly higher (Stark, 1998) than the median by 16 units and was the highest score recorded at this site to date. The summer 2018 (75 units) score was significantly (Stark, 1998) lower than the historical median by 11 units. The MCI scores in spring and summer respectively categorised this site as having 'good' and 'poor' health generically (Table 3). The historical median score (86 units) placed this site in the 'fair' category for generic health.

3.2.3.3.2 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site near the coast is in the lower reaches at an altitude of 5 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 93 units. The historical and summer scores were not significantly different to the REC value (Stark, 1998).

3.2.3.3.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 13) using the full dataset. A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1996-2018) and the most recent ten-years of results (2008-2018) from the site in the Huatoki Stream near the coast.



N = 43
Kendall tau = 0.017
p level = 0.873
FDR p = 0.900

N = 19
Kendall tau = 0.089
p level = 0.595
FDR p = 0.750

Figure 13 LOWESS trend plot of MCI data for the site in the Huatoki Stream near the coast for the full dataset with a Mann-Kendall test for the full and ten-year dataset

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

A non-significant positive trend in MCI scores has been found over the ten-year period congruent with the result found in the full dataset. The trendline was indicative of 'fair' health.

3.2.3.4 Discussion

Historically, there have been small summer decreases of MCI scores (Appendix II) in the Huotoki Stream but for the current monitoring period there were significant decrease in MCI scores from spring to summer at all three sites, probably as a result of drier than usual weather causing more stable flows and periphyton growth.

The two upper sites at Hadley Drive and Huatoki Domain, as was normal, had significantly higher macroinvertebrate health than the lower site on Molesworth Street. There was little difference in the overall health between the two upstream communities in spring but the Huatoki Domain site had a significantly higher MCI score than the upper Hadley Drive site, probably as a result of the Huotoki Domian site have better shading which helped to minimise periphyton growth, which was abundant at the upper site at the time of sampling. The significant decrease at the lower site can be attributed to .increased urbanisation, habitat modification and deterioration in water quality.

3.2.4 Kapoaiaia Stream

The Kapoaiaia Stream is a small ringplain stream running east to west with a source situated inside Egmont National Park. This stream was selected for the purpose of monitoring a western Taranaki ringplain catchment with minimal existing riparian vegetation cover. Three sites in the Kapoaiaia Stream were included in the SEM programme commencing in the 2000-2001 year. These were 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 (8 km further downstream, i.e. 25 km below the National Park boundary).

The results of the spring 2017 and summer 2018 surveys are presented in Table 75 and Table 76, Appendix I.

3.2.4.1 Wiremu Road site (KPA000250)

3.2.4.1.1 Taxa richness and MCI

Thirty-six surveys have been undertaken in the Kapoaiaia Stream between March 1998 and March 2017 at this open, upper mid-reach site in farmland, 5.7 km downstream of the National Park. These results are summarised in Table 11 together with the results from the current period, and illustrated in Figure 14.

Table 11 Results of previous surveys performed in the Kapoaiaia Stream at Wiremu Road together with the 2017-2018 results

Site code	SEM data (1998 to March 2017					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000250	36	19-31	25	83-131	117	27	120	24	113

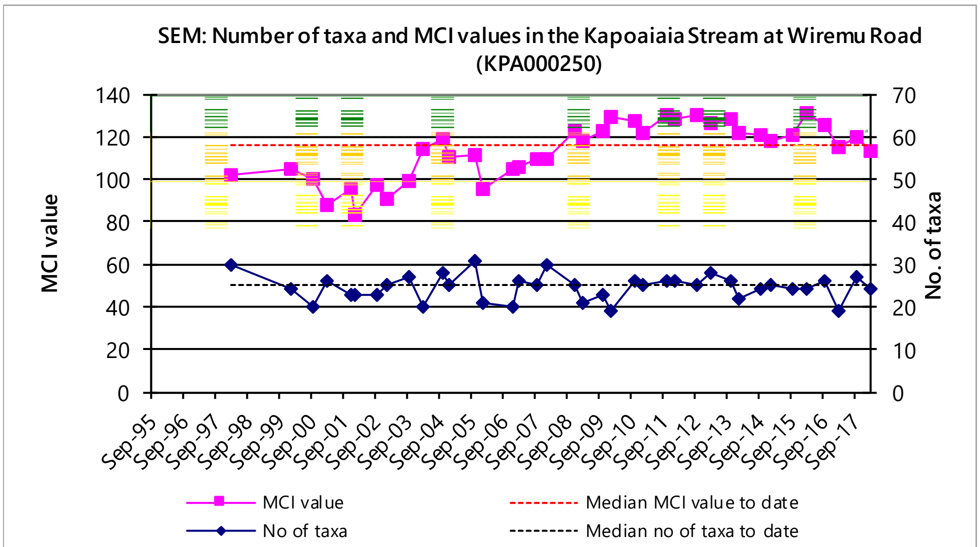


Figure 14 Numbers of taxa MCI values in the Kapoaiaia Stream at Wiremu Road

A moderate range of richness (19 to 31 taxa) has been found with a median richness of 25 taxa (more typical of richness in the mid-reaches of ringplain streams and rivers). During the 2017-2018 period, spring (27 taxa) and summer (24 taxa) richness were only three taxa apart and within two taxa of the historical median.

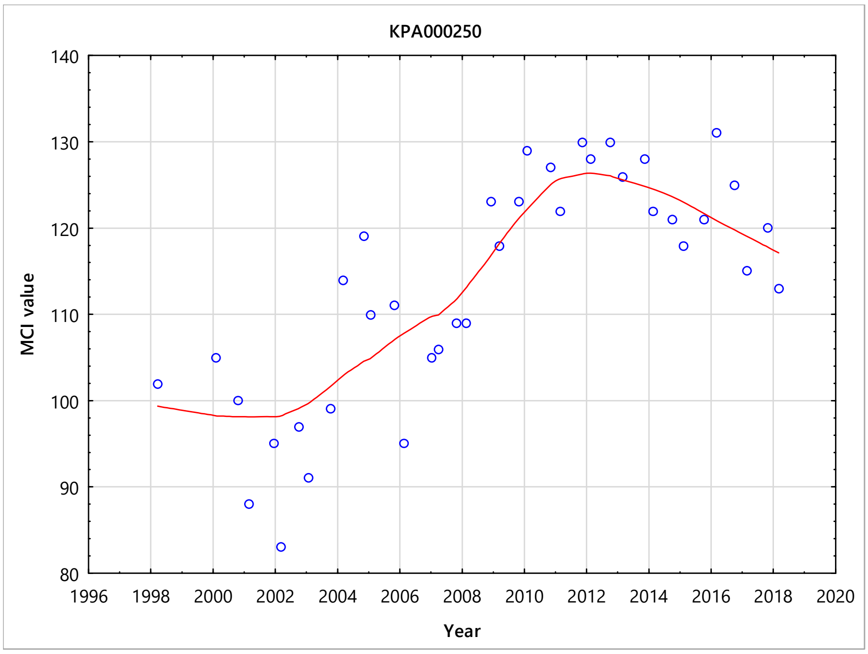
MCI values have had a wide range (48 units) at this site, wider than typical of a site in the upper mid-reaches of a ringplain stream although this site is in a reach of very open farmland, nearly 6km downstream from the National Park boundary. The spring 2017 (120 units) and summer 2018 (113 units) scores were not significantly different (Stark, 1998) from the historical median. These scores categorised this site as having 'very good' generic health (Table 3) in spring and 'good health' in summer. The historical median score (117 units) placed this site in the 'good' generic health category.

3.2.4.1.2 Predicted stream 'health'

The Kapoaiaia Stream site at Wiremu Road is 5.7 km downstream of the National Park boundary at an altitude of 240 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 112 for this site. The historical site median, spring and summer surveys were not significantly different from the distance predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 111 units. The historical median, spring and summer scores were not significantly different to the REC value.

3.2.4.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 15) using the full dataset. A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 20 years of SEM results (1998-2018) and the most recent ten-years of results (2008-2018) from the site in the Kapoaiaia Stream at Wiremu Road.



N = 38
Kendall tau = 0.490
p level < 0.001
FDR, p < 0.001

N = 20
Kendall tau = -0.278
p level = 0.086
FDR, p = 0.450

Figure 15 LOWESS trend plot of MCI data in the Kapoaiaia Stream at the Wiremu Road site

A very significant trend of improvement in MCI scores has been found over the 20 year duration of this monitoring period (FDR p < 0.01). There has been an ecologically important variability in the extremely wide (28 units) range of trendline scores at this site also. This appears to have been related to farming practices, particularly variations in fertiliser usage, through the open reach between the National Park boundary and this upper site, which may have been exacerbated by the lack of riparian vegetation along this reach.

The trendline scores were indicative of generic stream health 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 2018 period.

A non-significant negative trend in MCI scores has been found over the ten-year period in contrast with the result found in the full dataset. The trendline was mostly indicative of 'very good' health for the most recent ten-year period but has recently decreased to 'good' health.

3.2.4.2 Wataroa Road site (KPA000700)

3.2.4.2.1 Taxa richness and MCI

Thirty-six surveys have been undertaken in the Kapoaiaia Stream at this mid-reach site at Wataroa Road between December 1996 and March 2017. These results are summarised in Table 12, together with the results from the current period, and illustrated in Figure 16.

Table 12 Results of previous surveys performed in the Kapoaiaia Stream at Wataroa Road, together with 2017-2018 results

Site code	SEM data (1996 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000700	36	12-30	21	78-118	96	23	103	23	103

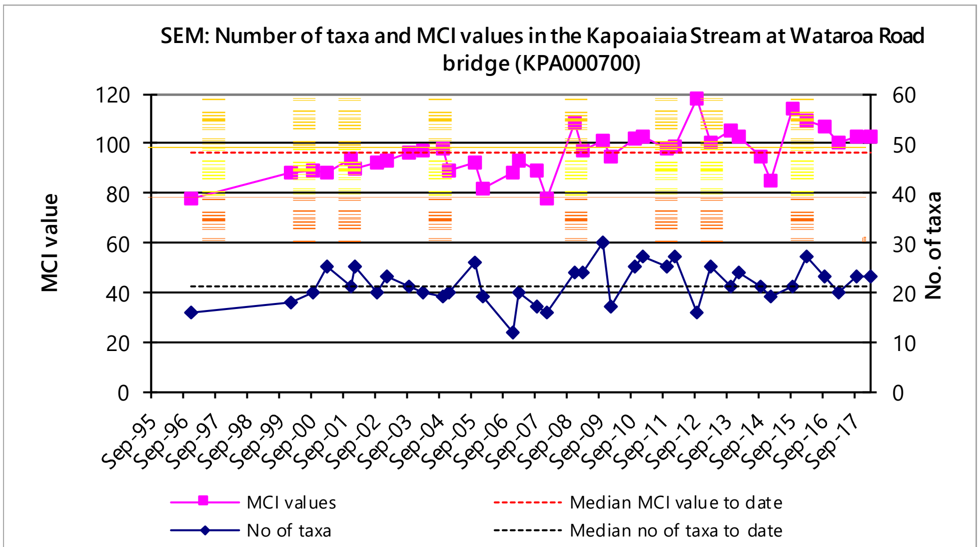


Figure 16 Numbers of taxa and MCI values in the Kapoaiaia Stream at Wataroa Road

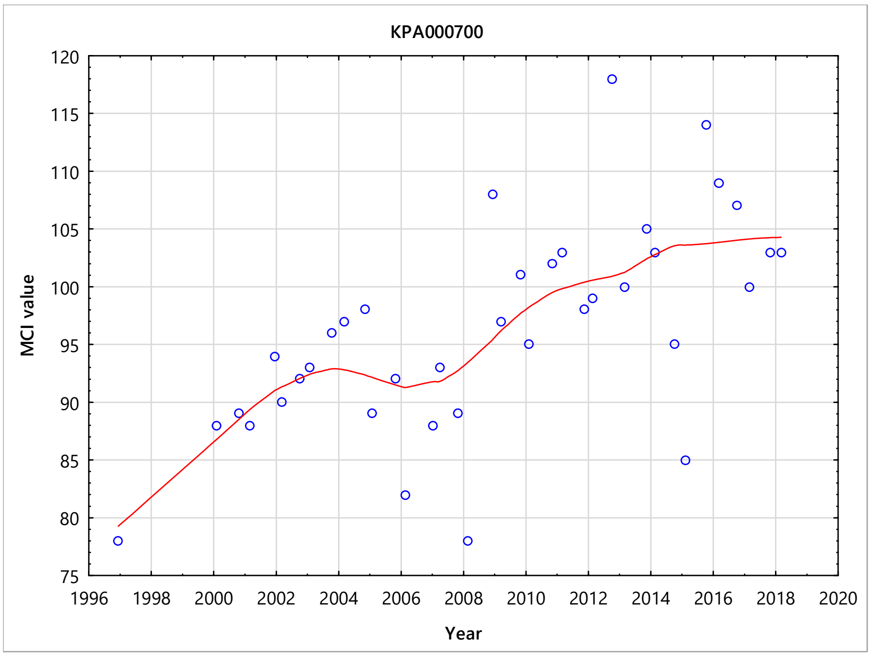
A wide range of richness (12 to 30 taxa) has been found, with a median richness of 21 taxa, relatively typical of richness in the mid-reaches of ringplain streams and rivers. During the 2017-2018 period, spring (23 taxa) and summer (23 taxa) richness were similar to the historical median. MCI values have had a relatively wide range (40 units) at this site, more so than typical of many sites in the mid-reaches of ringplain rivers. The historical median value (96 units) is lower than values typical of mid-reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (103 units) and summer 2018 (103 units) scores were similar to the historical median. These scores categorised this site as having 'good' (spring and summer) health generically (Table 3). The historical median score (96 units) placed this site in the 'fair' category for generic health.

3.2.4.2.2 Predicted stream 'health'

The Kapoaiaia Stream site at Wataroa Road, is 13.5 km downstream of the National Park boundary at an altitude of 140 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 103 for this site. The historical site median (96) was not significantly different to the distance predictive value, while the spring 2017 and summer, 2018 scores were both equal to the predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 105 units. The historical median, spring and summer scores were all not significantly different to the REC predictive value.

3.2.4.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 17). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1996-2018) and the most recent ten-years of results (2008-2018) from the site in the Kapoaiaia Stream at Wataroa Road.



N = 38
Kendall tau = 0.505
p level < 0.001
FDR p < 0.001

N = 20
Kendall tau = +0.140
p level = 0.389
FDR p = 0.630

Figure 17 LOWESS trend plot of MCI data in the Kapoaiaia Stream at the Wataroa Road site

There was a significant positive trend over the 22-year period (FDR $p < 0.01$). Although the initial six years of the monitoring programme indicated a significant temporal improvement in MCI scores, these tended to decline between 2004 and 2007. However, more recent improvement have continued a positive trend. The range of trendline scores (28 units) have been ecologically important although it has been influenced by an initial very low score. This trend of improvement had been influenced probably by the same drivers of the marked improvement at the Wiremu Road site upstream. MCI scores across the trendline have consistently indicated 'fair' generic stream health at this mid-catchment site, improving to 'good' from 2012 onwards.

A non-significant positve trend in MCI scores has been found over the ten-year period. The trendline was mostly indicative of 'good' health for the most recent ten-year period.

3.2.4.3 Upstream of coast site (KPA000950)

3.2.4.3.1 Taxa richness and MCI

Thirty-six surveys have been undertaken at this lower reach site near the coast in the Kapoaiaia Stream between December 1996 and March 2017. These results are summarised in Table 13, together with the results from the current period, and illustrated in Figure 18.

Table 13 Results of previous surveys performed in the Kapoaiaia Stream at the site upstream of the coast together with 2017-2018 results

Site code	SEM data (1996 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000950	36	15-25	19	76-101	87	19	93	20	82

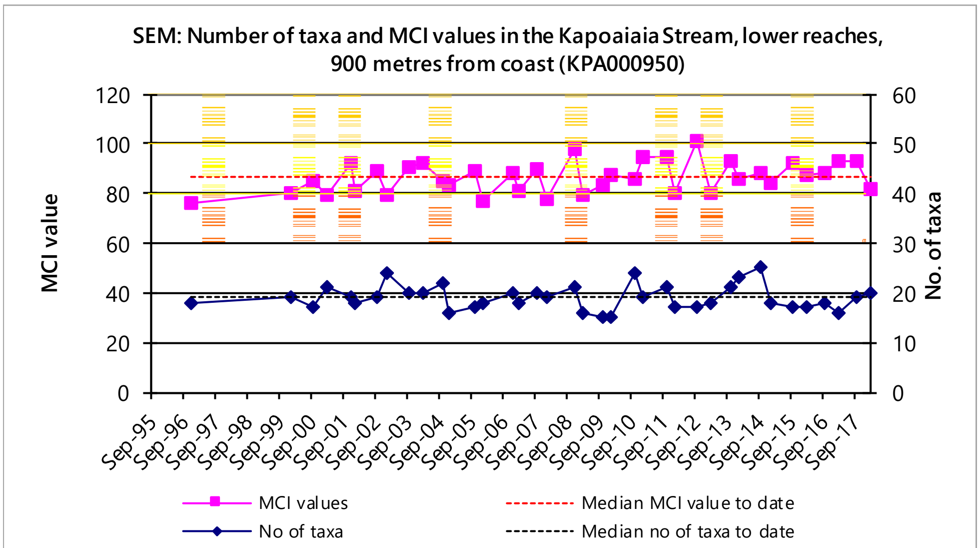


Figure 18 Numbers of taxa and MCI values in the Kapoaiaia Stream at the Cape Egmont (upstream of coast) site

A moderate range of richness (15 to 25 taxa) has been found with a median richness of 19 taxa relatively typical of richness in the lower reaches of ringplain streams and rivers. During the 2017-2018 period, spring (19 taxa) and summer (20 taxa) richness were similar to the historical median.

MCI scores have had a moderate range (25 units) at this site, slightly narrower than typical of sites in the lower reaches of ringplain streams. However, the median value (87 units) has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (93 units) and summer 2018 (82 units) scores were not significantly different from the historical median. The MCI scores categorised this site as having 'fair' (spring and summer) health generically (Table 3). The historical median score (87 units) also placed this site in the 'fair' category for generic health.

3.2.4.3.2 Predicted stream 'health'

The Kapoaiaia Stream site near the coast is 25.2 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 96 for this site. The historical site median (87 units) is nine units lower than the distance predictive value. The spring 2017 survey (93 units) score was not significantly different to the predictive value, while the summer 2018 (82 units) was significantly lower than this value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 99 units. The historical median and summer scores were significantly lower than the REC value (Stark, 1998) by 12 and 17 units respectively while the spring score was not significantly different.

3.2.4.3.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 19). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1996-2018) and the most recent ten-years of results (2008-2018) from the site in the Kapoaiaia Stream at near the coast.

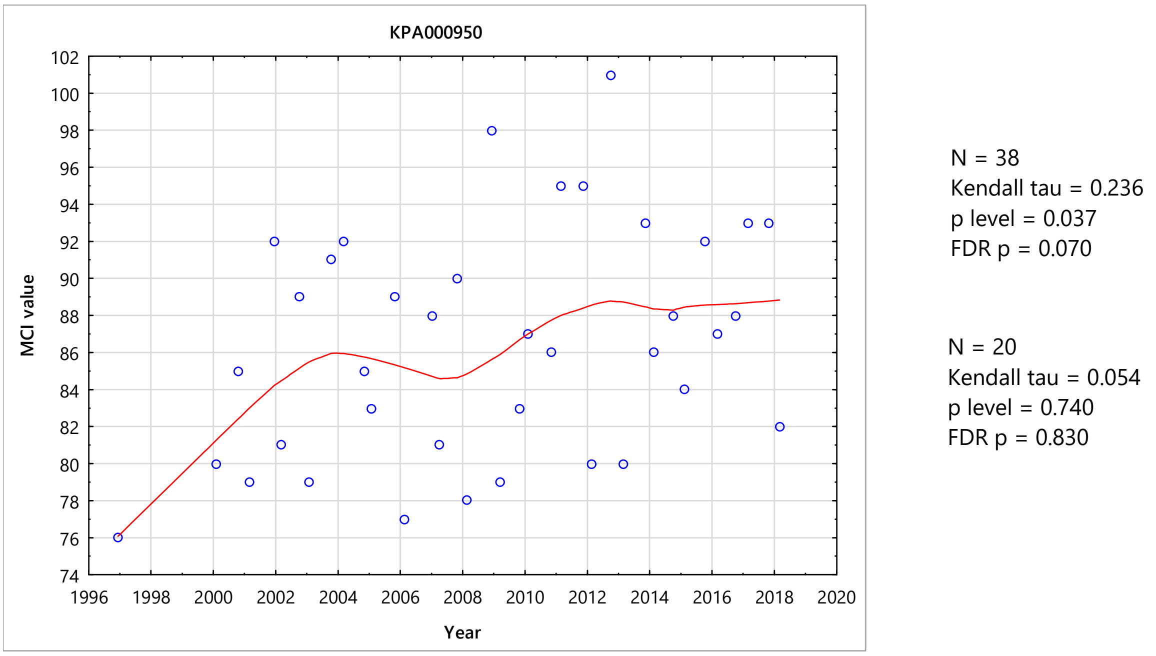


Figure 19 LOWESS trend plot of MCI data at the site upstream of the coast

The positive trend was close to being statistically significant after FDR application and continued improvement in the future will likely produce a statistically significant trend. There has been a similar, although more pronounced, trend at the mid-catchment site at Wataroa Road. However, there has been an ecologically important range (of 13 units) across the trendline, influenced by the low initial score, but not as wide as the range at the nearest upstream site. Subsequent to the December 1996 survey, no usage of the Pungarehu Dairy Factory (between the two sites) has occurred and since 2000 there has been a narrower, ecologically insignificant, range of MCI scores (eight units). In more recent years, there has been an increase in water abstraction in the lower reaches for irrigation purposes. The trendline range of MCI scores have consistently been indicative of 'fair' generic stream health although individual scores prior to 2010 have occasionally indicated 'poor' health, invariably under summer (warmer and lower) flow conditions.

A non-significant positve trend in MCI scores has been found over the ten-year period congruent with the full dataset though with a far weaker p value indicating a weaker trend and smaller dataset. The trendline was indicative of 'fair' health for the most recent ten-year period.

3.2.4.4 Discussion

MCI scores showed a significant decrease in a downstream direction for both spring and summer surveys. MCI scores at the upper site were 'very good' to 'good', 'good' at the middle site and 'fair' at the lower site indicationg a deterioration in macroinvertebrate health as the stream flows through agricultural land. The deterioration in macroinvertebrate health was likely due to nutrient enrichment from cumulative inputs from point and diffuse sources. However, the two upper sites had significant positive trends indicating long term improvement and the lower site also appeared to be improving, but not to the same degree as the upper sites.

3.2.5 Katikara Stream

The Katikara Stream is a ringplain stream running from east to west arising within Egmont National Park. Two sites in the Katikara Stream, one located near the headwaters (just inside the National Park) and the other near the coast, were first included in the SEM programme in the 2000-2001 year, for the purpose of long term monitoring of the progressive impacts of riparian vegetation planting initiatives within this north-western Taranaki catchment. In the 2008-2009 period severe headwater erosion events impacted upon the macroinvertebrate communities of the upper reaches of this stream (TRC, 2009). The results for the spring 2017 and summer 2018 surveys are presented Table 77 and Table 78 in Appendix I.

3.2.5.1 Carrington Road site (KTK000150)

3.2.5.1.1 Taxa richness and MCI

Thirty-five 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 2017. These results are summarised in Table 14 together with the results from the current period, and illustrated in Figure 20.

Table 14 Results of previous surveys performed in the Katikara Stream at Carrington Road, together with 2017-2018 results

Site code	SEM data (1999 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KTK000150	35	11-38	28	112-148	135	23	143	22	132

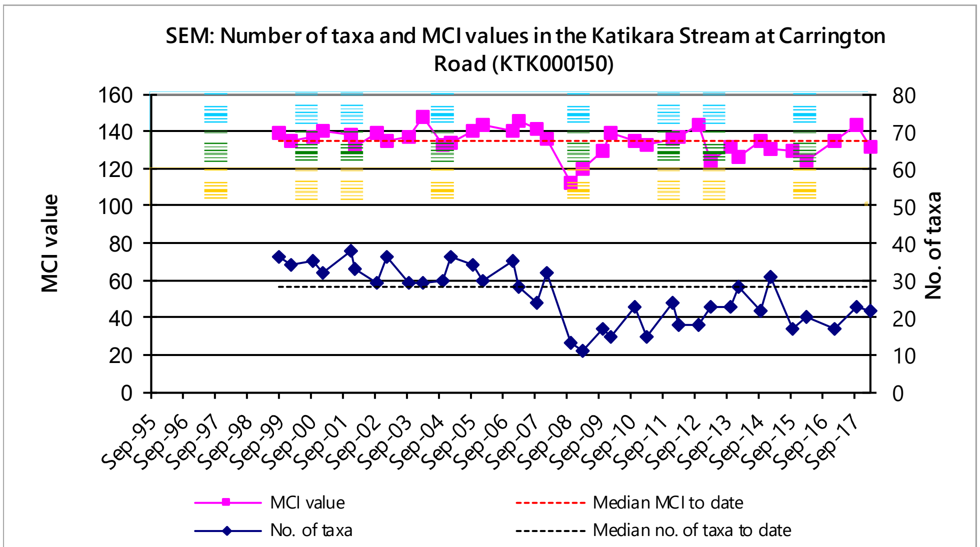


Figure 20 Numbers of taxa and MCI values in the Katikara Stream at Carrington Road

A very wide range of richness (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 28 taxa has been far more representative of typical richness in ringplain streams and rivers near the National Park boundary (TRC, 2017b), although median richness since the 2008-

2009 erosion event has been 20 taxa. During the 2017-2018 period spring (23 taxa) and summer (22 taxa) richness was below the long-term median richness indicative of a continuing post-headwater erosion recovery phase and resulting in degradation of the physical habitat.

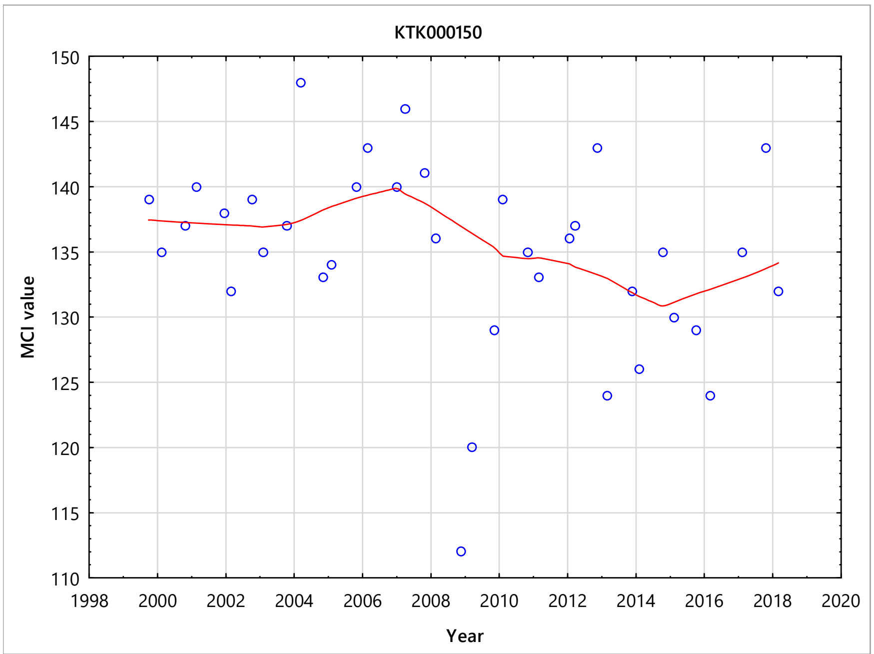
MCI values at this site have had a wider range (36 units) than typical of a National Park boundary site, due in part to atypically lower values for a short period and on other isolated occasions since the 2008-2009 headwater erosion event. The median value (135 units) has been typical of upper reach sites (near or within the National Park) elsewhere on the ringplain (TRC, 2017b). The spring 2017 (143 units) and summer 2018 (132 units) scores were not significantly different to the historical median (135 units). The spring and summer scores respectively categorised this site as having 'excellent' and 'very good' health generically (Table 3) although taxa numbers in general continued to be lower than typical pre-erosion richness. The historical median score (135 units) also placed this site in the 'very good' category for the generic health.

3.2.5.1.2 Predicted stream 'health'

The Katikara Stream at Carrington Road is within the National Park boundary at an altitude of 420 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI value of 132 for this site. The historical site median (135 units) is three units higher than the distance predictive value. The spring score was a significant (Stark, 1998) 11 units higher than this value, while the summer (132 units) score was not significantly different to the predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 131 units. Again, the historical and summer scores were not significantly different to the REC value (Stark, 1998), while the spring score was a significant 12 units higher.

3.2.5.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 21). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 19 years of SEM results (1999-2018) and the most recent ten-years of results (2008-2018) from the site in the Katikara Stream at Carrington Road.



N = 37
Kendall tau = -0.235
p level = 0.041
FDR p = 0.080

N = 19
Kendall tau = 0.119
p level = 0.475
FDR p = 0.700

Figure 21 LOWESS trend plot of MCI data in the Katikara Stream at the Carrington Road site for the full dataset and a Mann-Kendall test for the full and ten-year dataset

A negative non-significant trend was found for the full dataset. 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 subsequent limited recovery. The range of scores found across the trendline (15 units) over the period has been of marginal ecological importance with the range having widened appreciably since the erosion event. However, the trendline was indicative of 'very good' generic stream health throughout the period, bordering on 'excellent' in the 2006-2007 period.

In contrast to the full dataset, there was a non-significant positve trend in MCI scores over the most recent ten-year period. The trendline was indicative of 'very good' health for the most recent ten-year period.

3.2.5.2 Coastal site (KTK000248)

3.2.5.2.1 Taxa richness and MCI

Thirty-three surveys have been undertaken in the Katikara Stream at this lower reach site near the coast between October 2000 and February 2017. The exact position of the site has been shifted slightly upstream from the summer 2016 survey onwards to avoid being flooded when the stream outlet blocks during low summer flows. The results of the thirty-three surveys are summarised in Table 15, together with the results from the current period, and illustrated in Figure 22.

Table 15 Results of previous surveys performed in the Katikara Stream near the coast together with 2017-2018 results

Site code	SEM data (2000 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KTK000248	33	17-31	26	87-118	102	25	102	19	95

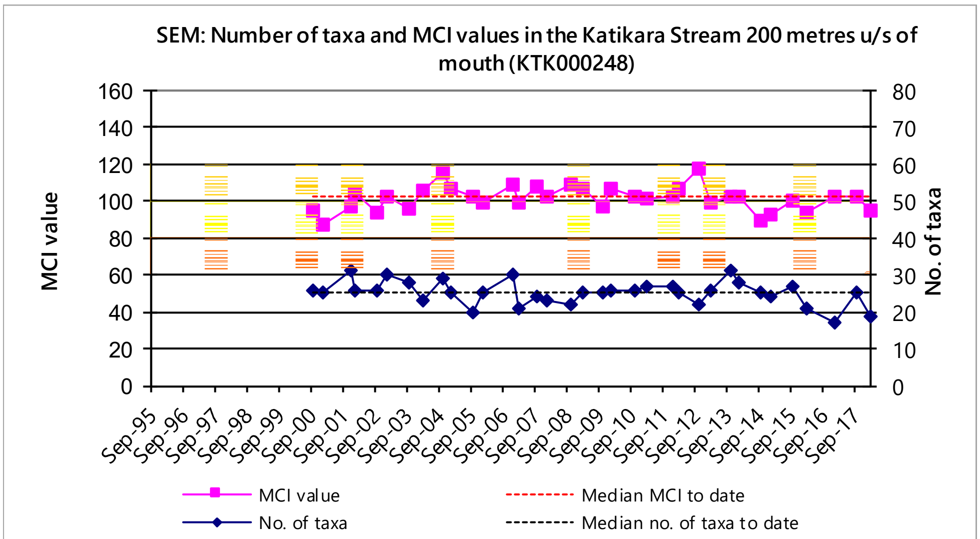


Figure 22 Numbers of taxa and MCI values in the Katikara Stream 200m u/s of the coast

A moderate range of richness (17 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 richness elsewhere in the lower reaches of ringplain streams and rivers (TRC, 2017b). During the 2017-2018 period, spring taxa richness (25 units) was only one taxon lower than the historical median, while the summer taxa richness (19 taxa) seven taxa lower than the historical median.

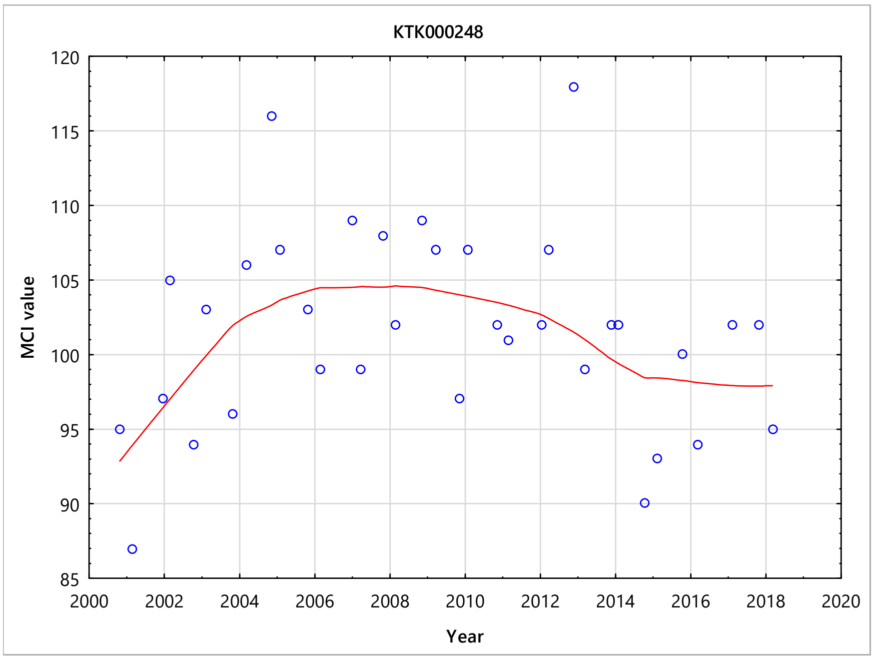
MCI values have had a relatively wide range (31 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (102 units) has been higher than typical of lower reach sites elsewhere on the ringplain however (TRC, 2017b). The spring (102 units) and summer (95 units) scores were not significantly different from the historical median. The MCI scores in spring and summer respectively categorised this site as having 'good' and 'fair' health generically (Table 3). The historical median score (102 units) also placed this site in the 'good' category for generic health.

3.2.5.2.2 Predicted stream 'health'

The Katikara Stream at the site near the coast is 18.1 km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 99 for this site. The historical site median (102) was not significantly different from the distance predictive value. The spring (95 units) and summer scores (102 units) was also not significantly different to predictive values. The REC predicted MCI value (Leathwick, et al. 2009) was 96 units. The historical, spring and summer scores were not significantly different to the REC value (Stark, 1998).

3.2.5.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 23). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 18 years of SEM results (2000-2018) and the most recent ten-years of results (2008-2018) from the site in the Katikara Stream near the coast.



N = 35
Kendall tau = -0.052
p level = 0.661
FDR p = 0.770

N = 19
Kendall tau = -0.352
p level = 0.035
FDR p = 0.360

Figure 23 LOWESS trend plot of MCI data in the Katikara Stream at the coastal site for the full dataset and a Mann-Kendall test for the full and ten-year dataset

The trend over the 18 year period has not been significant (FDR $p > 0.05$). A relatively strong improvement in MCI scores has been recorded from 2000 to 2006 but then plateaued from 2006-2008 before decreasing from 2008 onwards coincident with the headwater erosion event also decreasing MCI scores and taxa richness at the upstream site. There had been a positive significant improvement at the site before the prolonged effects of the headwater erosion event had decreased MCI scores and the wide range of MCI scores (11 units) found throughout the trendline have been of ecological importance coincidentally with retirement and riparian planting of the margins of the lower reaches of this stream. The trendline range of scores indicative of 'fair' generic stream health have improved to 'good' health after 2003 where they remained until a return to 'fair' health most recently.

There was a non-significant negative trend in MCI scores over the most recent ten-year period. The trendline was indicative of 'good' health deteriorating to 'fair' health post 2013 for the most recent ten-year period.

3.2.5.3 Discussion

Historically, seasonal median scores have remained very similar at the National Park and coastal sites which was consistent with the results from the current monitoring period. MCI scores fell significantly in a downstream direction over a stream distance of 18.1 km downstream from the National Park boundary which was typical for Taranaki ringplain streams. MCI scores for the upper site indicated 'very good' to 'excellent' macroinvertebrate health while the lower site indicated 'good' to 'fair' health. The deterioration in macroinvertebrate health was likely due to nutrient enrichment from cumulative inputs from point and diffuse sources.

MCI scores were typical for both sites with little difference between the current survey and historical medians which contrasts with recent surveys where headwater erosion was attributed to lower scores, especially at the upper site.

3.2.6 Kaupokonui River

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

The results of the spring 2017 and summer 2018 surveys are presented in Table 79, Table 17 and Table 80, Appendix I.

3.2.6.1 Opunake Road site (KPK000250)

3.2.6.1.1 Taxa richness and MCI

Thirty-seven 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 2017. These results are summarised in Table 16, together with the results from the current period, and illustrated in Figure 24.

Table 16 Results of previous surveys performed in the Kaupokonui River at Opunake Road, together with spring 2017 and summer 2018 results

Site code	SEM data (1998 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000250	37	20-36	27	124-139	130	27	132	22	133

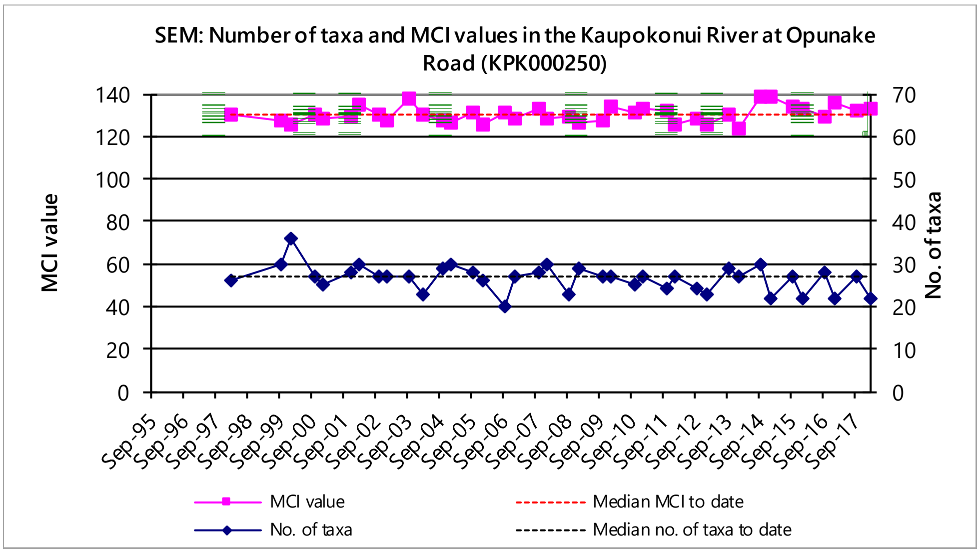


Figure 24 Numbers of taxa and MCI values in the Kaupokonui River at Opunake Road

A relatively wide range of richness (20 to 36 taxa) has been found; wider than might be expected, with a median richness of 27 taxa (more representative of typical richness in the upper mid-reaches of ringplain streams and rivers). During the 2017-2018 period spring (27 taxa) and summer (22 taxa) richness were relatively similar to the historical median.

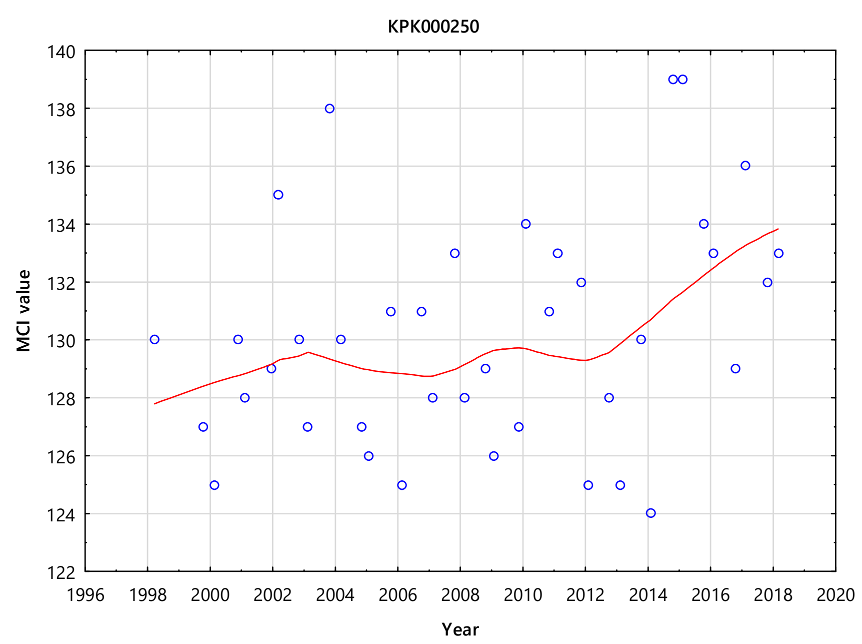
MCI values have had a narrow range (15 units) at this site, more typical of sites in the upper reaches of ringplain rivers. The median value (130 units) has been higher than typical of mid-reach sites elsewhere on the ringplain. The spring 2017 (132 units) and summer 2018 (133 units) scores were very similar to each other and non-significantly different to the historical median. These scores categorised this site as having 'very good', (spring and summer) health generically (Table 3). The historical median score (130 units) placed this site in the 'very good' category for generic health.

3.2.6.1.2 Predicted stream 'health'

The Kaupokonui River site at Opunake Road is 3.3 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 118 for this site. The historical site median (130) is significantly higher (Stark, 1998) by 12 units than the distance predictive value. The spring 2017 score (132 units) and summer score (133 units) were both significantly higher than the distance value. The REC predicted MCI value (Leathwick, et al. 2009) was 137 units. The historical, spring and summer scores were also not significantly different to the REC value (Stark, 1998).

3.2.6.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 25). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 20 years of SEM results (1998-2018) and the most recent ten-years of results (2008-2018) from the site in the Kaupokonui River at Opunake Road.



N = 39
Kendall tau = 0.196
p level = 0.079
FDR p = 0.130

N = 20
Kendall tau = 0.226
p level = 0.164
FDR p = 0.460

Figure 25 LOWESS trend plot of MCI data in the Kaupokonui River at the Opunake Road site for the full dataset and a Mann-Kendall test for the full and ten-year dataset

MCI scores have not been statistically significant at this site in the upper mid-reaches of the river over the 20-year monitoring period. The trendline was has been narrow and not ecologically important. The trendline was indicative of 'very good' generic river health.

There was a non-significant positive trend in MCI scores over the most recent ten-year period congruent with the full dataset. The trendline was indicative of 'very good' health for the most recent ten-year period.

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

3.2.6.2.1 Taxa richness and MCI

Forty 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 2017. These results are summarised in Table 17, together with the results from the current period, and illustrated in Figure 26.

Table 17 Results of previous surveys performed in the Kaupokonui River at the site upstream of the Kaponga oxidation ponds system together with 2017-2018 results

Site code	SEM data (1996 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000500	40	20-33	26	98-133	116	24	128	25	123

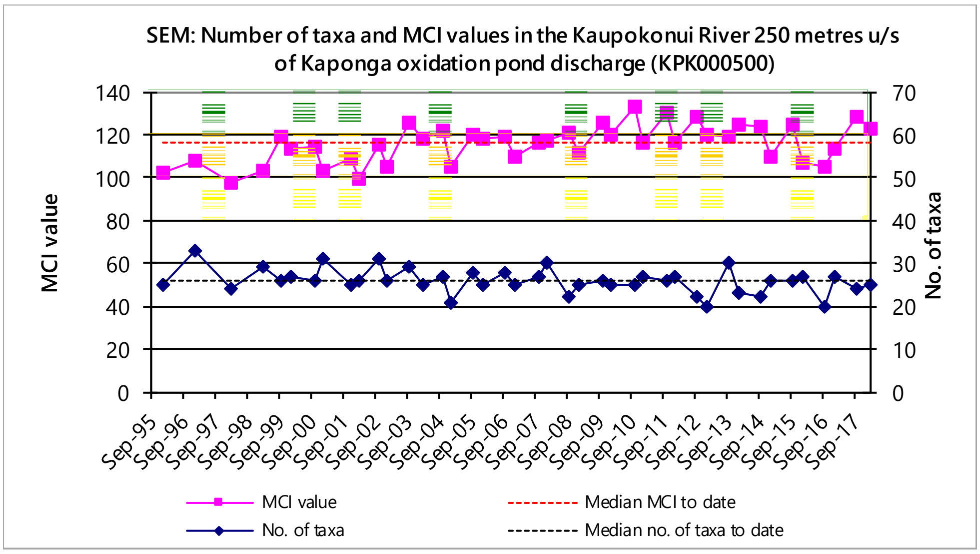


Figure 26 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kaponga oxidation pond system

A moderate range of richness (20 to 33 taxa) has been found with a median richness of 26 taxa, typical of richness in the mid reaches of ringplain streams and rivers. During the 2017-2018 period, spring (24 taxa) and summer (25 taxa) richness were very similar to each other and to the historical median.

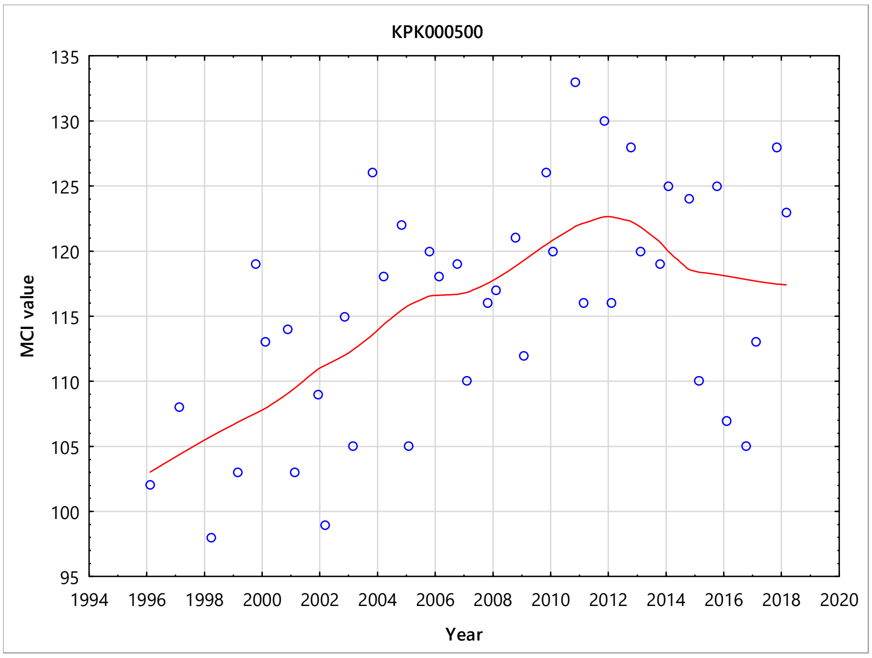
MCI values have had a relatively wide range (35 units) at this site, slightly wider than typical of sites in the mid-reaches of ringplain rivers. The median value (116 units) has been very slightly higher than typical of mid-reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (128 units) was significantly higher than the median but the summer 2018 (123 units) score was not significantly different (Stark, 1998). The MCI scores categorised this site as having 'very good' (spring and summer) health generically (Table 3). The historical median score (116 units) placed this site in the 'good' category for generic health.

3.2.6.2.2 Predicted stream 'health'

The Kaupokonui River site upstream of the Kaponga oxidation pond system is 9.2 km downstream of the National Park boundary at an altitude of 260 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 107 for this site. The historical site median (116) is nine units higher than the distance predictive value. The spring 2017 (128 units) and summer 2018 (123 units) scores were significantly higher than the predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 127 units. The historical, spring and summer scores was not significantly different to the REC value (Stark, 1998).

3.2.6.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 27). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1996-2018) and the most recent ten-years of results (2008-2018) from the site in the Kaupokonui River upstream of the Kaponga oxidation ponds system.



N = 42
Kendall tau = 0.348
p level = 0.001
FDR p < 0.001

N = 20
Kendall tau = -0.149
p level = 0.359
FDR p = 0.620

Figure 27 LOWESS trend plot of MCI data at the site in the Kaupokonui River upstream of the Kaponga oxidation ponds system for the full datset with a Mann-Kendall test for the full and ten-year dataset

A significant positive trend in MCI scores has been found over the 22 year period (FDR p < 0.01). Improvements may have been related partly to improved dairyshed wastes disposal consents' compliance reported in this catchment. Trendline scores consistently indicated 'good' generic river health with a brief period of 'very good' health from 2010-2014.

There was a non-significant negative trend in MCI scores over the most recent ten-year period in constrast to the full dataset due to a decline in MCI scores for the most recent surveys. The trendline for the most recent ten-year period was mostly indicative of 'good' health with a brief period of 'very good' health from 2010-2014.

3.2.6.3 Site upstream of Kapuni railbridge (KPK000660)

3.2.6.3.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Kaupokonui River at this mid-reach site upstream of the Kapuni railbridge between December 1995 and February 2017. These results are summarised in Table 18, together with the results from the current period, and illustrated in Figure 28.

Table 18 Results of previous surveys performed in the Kaupokonui River upstream of Kapuni railbridge, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000660	44	15-32	24	71-128	103	20	119	25	113

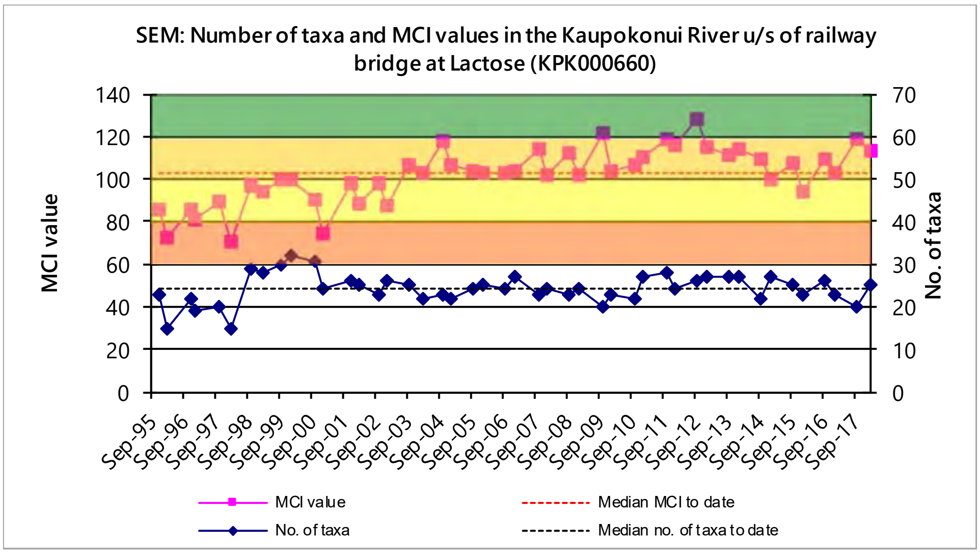


Figure 28 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kapuni railbridge

A wide range of richness (15 to 32 taxa) has been found with a median richness of 24 taxa (more representative of typical richness in the mid reaches of ringplain streams and rivers). During the 2017-2018 period spring (20 taxa) and summer (25 taxa) richness were relatively similar to each other and the historical median.

MCI values have had a very wide range (57 units) at this site, much wider than typical of sites elsewhere in the mid reaches of ringplain rivers. However, the median value (103 units) has been relatively typical of mid reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (119 units) and summer 2018 (113 units) scores were not significantly different from each other, and only the spring score was significantly different to the historical median (Stark, 1998).

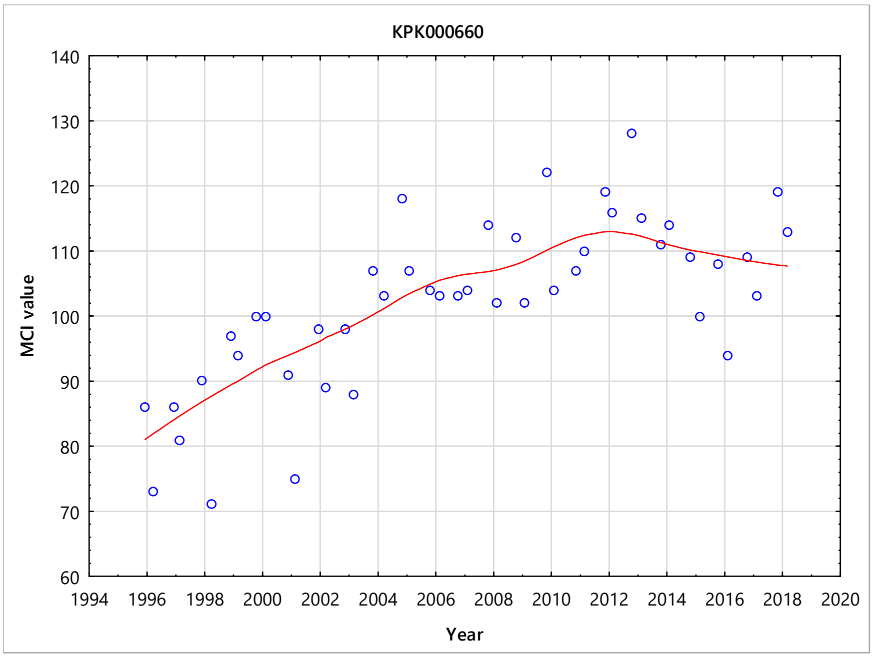
These scores categorised this site as having 'good' (spring and summer) health generically (Table 3). The historical median score (103 units) placed this site in the 'good' category for generic health.

3.2.6.3.2 Predicted stream 'health'

The Kaupokonui River site upstream of the Kapuni railbridge is 15.5 km downstream of the National Park boundary at an altitude of 170 m asl. Relationships for ringplain streams developed between MCI and and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value of 101 for this site. The historical site median (103) is two units above the distance predictive value. The spring 2017 (119 units) and summer 2018 (113 units) scores were significantly higher than the predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 122 units. The historical score was significantly lower than the REC value (Stark, 1998), while the spring and summer scores were not significantly different from this value.

3.2.6.3.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 29). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Kaupokonui River upstream of the Kapuni railbridge.



N = 46
Kendall tau = 0.530
p level < 0.001
FDR p < 0.001

N = 20
Kendall tau = -0.106
p level = 0.514
FDR p = 0.700

Figure 29 LOWESS trend plot of MCI data in the Kaupokonui River at the site upstream of Kapuni railbridge for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A highly significant improvement in MCI scores has been found over a 23-year period at this mid-catchment site (FDR $p < 0.01$). This trendline has a wide range (33 units) which has been ecologically 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 has moved from 'fair' to 'good' where it has remained since 2003.

There was a non-significant negative trend in MCI scores over the most recent ten-year period in contrast to the full dataset due to a decline in MCI scores for the most recent surveys. The trendline for the most recent ten-year period was mostly indicative of 'good' health. Since 2012 the MCI scores have declined and if this continues the trendline will fall back into the 'fair' category.

3.2.6.4 Upper Glenn Road site (KPK000880)

3.2.6.4.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Kaupokonui River at this lower reach site at Upper Glenn Road between 1995 and February 2017. These results are summarised in Table 19, together with the results from the current period, and illustrated in Figure 30.

Table 19 Results of previous surveys performed in the Kaupokonui River at Upper Glenn Road, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000880	44	14-31	19	66-110	91	15	97	16	91

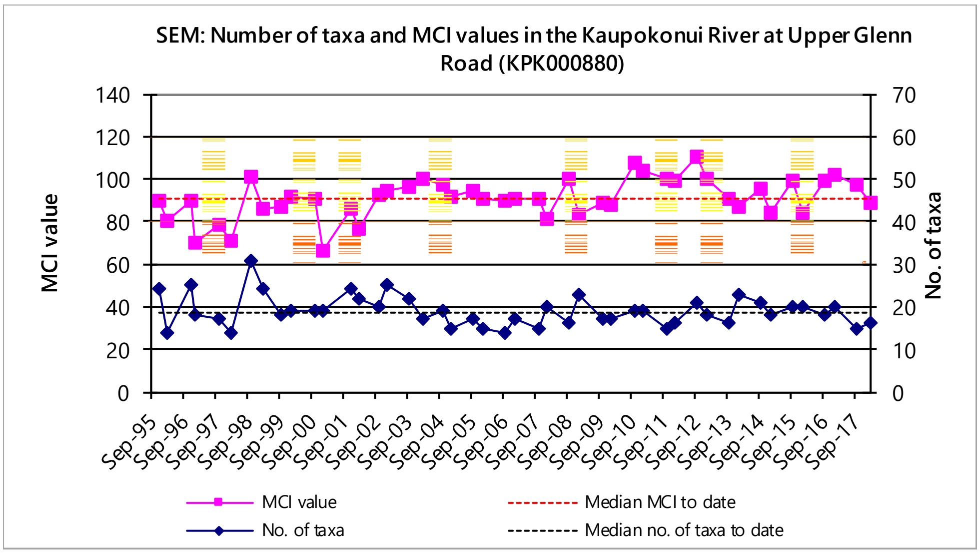


Figure 30 Numbers of taxa and MCI values in Kaupokonui River at Upper Glenn Road

A wide range of richness (14 to 31 taxa) has been found with a median richness of 19 taxa (typical of richness in the lower reaches of ringplain streams and rivers). During the 2017-2018 period spring (15 taxa) and summer (16 taxa) richness were similar to each other and to the historical median taxa number.

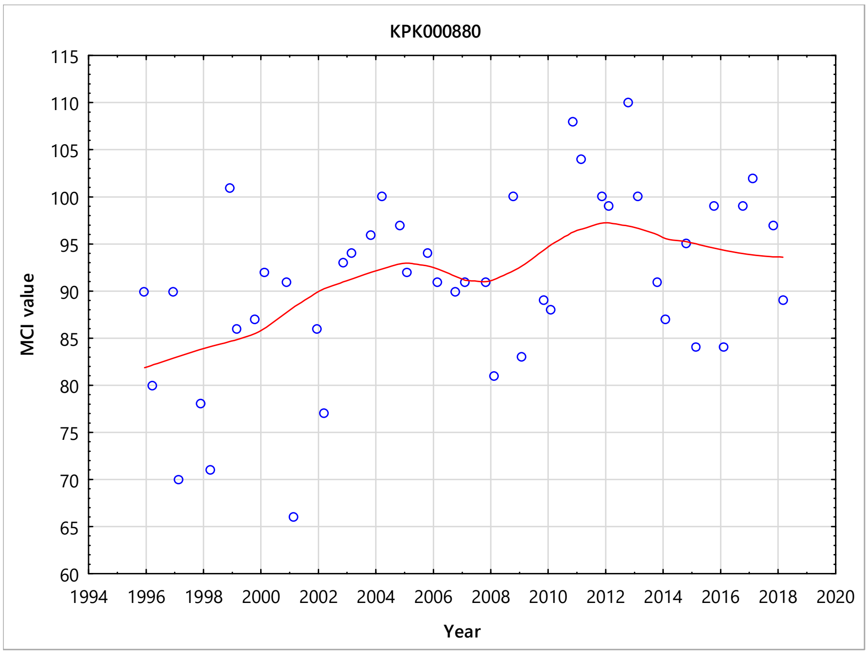
MCI values have had a very wide range (44 units) at this site, more typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been slightly lower than typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (97 units) and summer 2018 (91 units) scores were not significantly different from the historical median score. These scores categorised this site has having 'fair' (spring and summer) generically (Table 3). The historical median score (91 units) placed this site in the 'fair' category for generic health.

3.2.6.4.2 Predicted stream 'health'

The Kaupokonui River site at Upper Glenn Road is 25.7 km downstream of the National Park boundary at an altitude of 60 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value of 95 for this site. The historical site median (91) is four units lower than the predictive distance value. The spring 2017 score (97 units) and the summer 2018 score (91 units) were similar to predictive values. The REC predicted MCI value (Leathwick, et al. 2009) was 106 units. The historical and summer scores were significantly lower than the REC value but the spring score was not significantly different (Stark, 1998).

3.2.6.4.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 31). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Kaupokonui River at Upper Glenn Road.



N = 46
Kendall tau = 0.269
p level = 0.009
FDR p = 0.020

N = 20
Kendall tau = -0.108
p level = 0.507
FDR p = 0.700

Figure 31 LOWESS trend plot of MCI data in the Kaupokonui River at the Upper Glenn Road sitefor the full dataset with a Mann-Kendall test for the full and ten-year dataset

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

There was a non-significant negative trend in MCI scores over the most recent ten-year period in constrast to the full dataset, due to a decline in MCI scores over the last six years. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.6.5 Kaupokonui Beach site (KPK000990)

3.2.6.5.1 Taxa richness and MCI

Thirty-six surveys have been undertaken in the Kaupokonui River at this lower reach site at Kaupokonui Beach between 1999 and February 2017. These results are summarised in Table 20, together with the results from the current period, and illustrated in Figure 32.

Table 20 Results of previous surveys performed in the Kaupokonui River at the Kaupokonui Beach site, together with 2017-2018 results

Site code	SEM data (1999 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000990	36	11-26	19	69-103	91	21	102	13	74

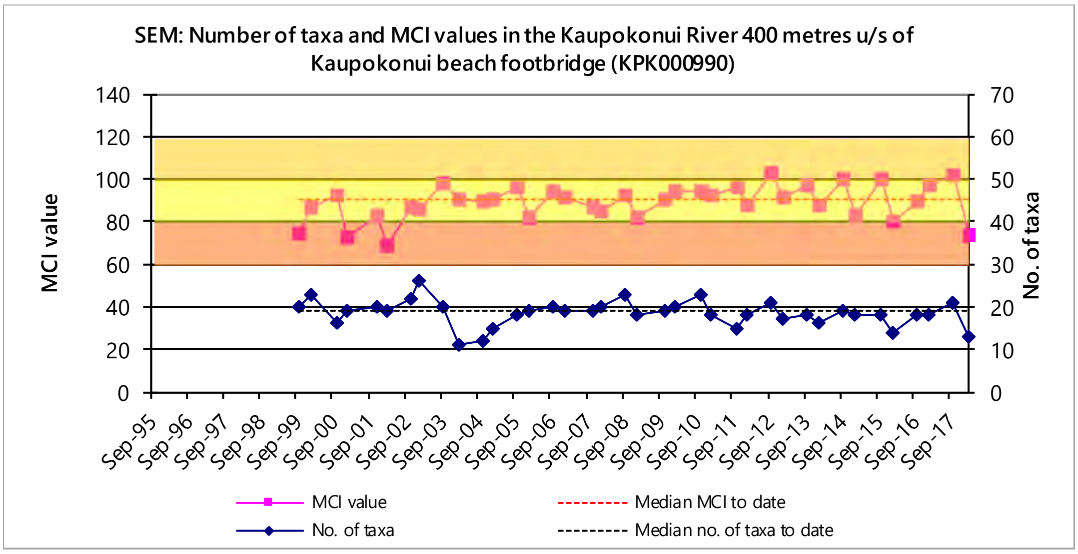


Figure 32 Numbers of taxa and MCI values in the Kaupokonui River at the Kaupokonui Beach site

A wide range of richness (11 to 26 taxa) has been found, with a median richness of 19 taxa. During the 2017-2018 period spring (21 taxa) and summer (13 taxa) richness varied substantially and were respectively two taxa higher and six taxa fewer than the historical median richness.

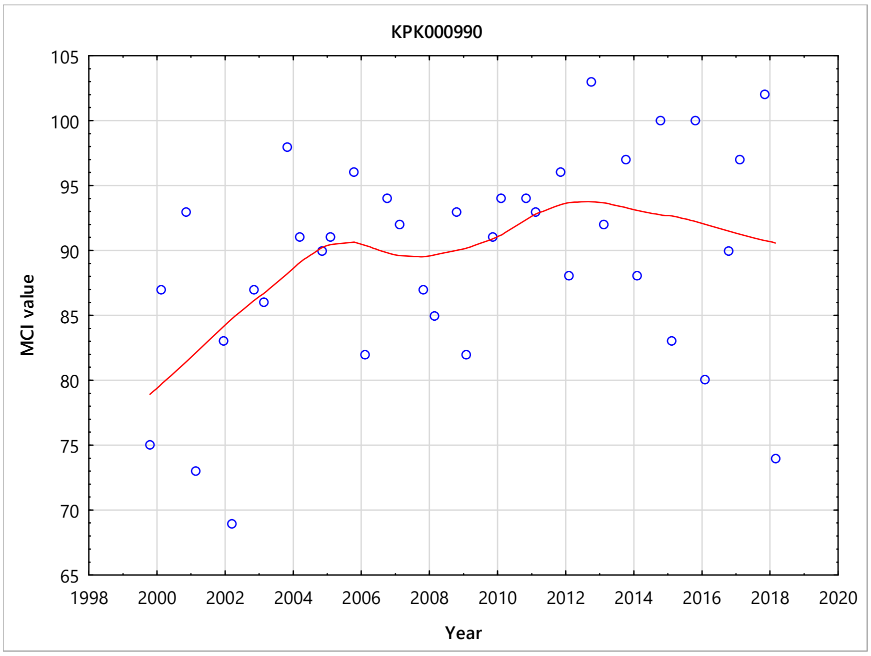
MCI values have had a moderate range (34 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (102 units) and summer 2018 (74 units) scores varied widely and were significantly different from the historical median. The MCI scores categorised this site as having 'good' (spring) and 'poor' (summer) health generically (Table 3). The historical median score (91 units) placed this site in the 'fair' category for generic health.

3.2.6.5.2 Predicted stream 'health'

The Kaupokonui River at the Kaupokonui Beach site is 31.1 km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams and rivers developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 93 for this site. The historical site median (91) is two units below the distance predictive value. The spring 2017 (102 units) score was not significantly different to the distance value, while the summer 2018 (74 units) value was significantly lower than the distance value. The REC predicted MCI value (Leathwick, et al. 2009) was 96 units. The historical and spring scores were also not significantly different to the REC value (Stark, 1998), while the summer value was signifncatly lower.

3.2.6.5.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 33). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 19 years of SEM results (1999-2018) and the most recent ten-years of results (2008-2018) from the site in the Kaupokonui River at Kaupokonui Beach.



N = 38
Kendall tau = 0.264
p level = 0.020
FDR p = 0.040

N = 20
Kendall tau = 0.037
p level = 0.818
FDR p = 0.860

Figure 33 LOWESS trend plot of MCI data in the Kaupokonui River at the Kaupokonui Beach site for the full datset with Mann-Kendall test for the full and ten-year dataset

There was a significant positive improvement over the 19 year time period (FDR $p < 0.05$) which showed a similar pattern to that of the site immediately upstream (KPK000880). The trendline has largely increased since 1999 to 2012 apart from a small dip from 2005-2008. The trendline had an ecologically important range of scores (14 units), although much narrower than ranges at the two nearest upstream sites, possibly reflecting certain upstream improvements in waste disposal management (documented earlier) which have had reduced impacts with greater distance downstream. The trendline range has been indicative of 'fair' generic river health throughout the period.

There was a non-significant minor postive trend in MCI scores over the most recent ten-year period. Since 2012, the trend has started to decline. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.6.6 Discussion

MCI scores deteriorated in a downstream direction for the current monitoring period with the upper site recording 'very good' health while the bottom site recording 'fair' health. MCI scores typically fall in a downstream direction between the upper site and the furthest downstream lower reaches site by 39 units over a river distance of 27.8 km. MCI scores were typical for all the sites except for the summer score at the bottom site which was significantly lower than usual. The lower site can be the most affected by periphyton and both mats and filamentous algae were widespread at the time of surveying. The general deterioration in macroinvertebrate health was likely due to nutrient enrichment from cumulative inputs from point and diffuse sources in combination with less shading, higher temperatures and smaller substrate sizes typically found at lower altitudes.

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

3.2.7 Kurapete Stream

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

The results of the 2017-2018 surveys are presented in Table 81 and Table 82, Appendix 1.

3.2.7.1 Site upstream of Inglewood WWTP (KRP000300)

3.2.7.1.1 Taxa richness and MCI

Forty-three surveys have been undertaken, between 1995 and February 2017, at this mid-reach, shaded site, draining developed farmland, downstream of Inglewood, but immediately upstream of the WWTP. These results are summarised in Table 21, together with the results from the current period, and illustrated in Figure 34.

Table 21 Results of previous surveys performed in the Kurapete Stream upstream of Inglewood WWTP, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KRP000300	43	13-32	22	80-106	94	14	97	12	107

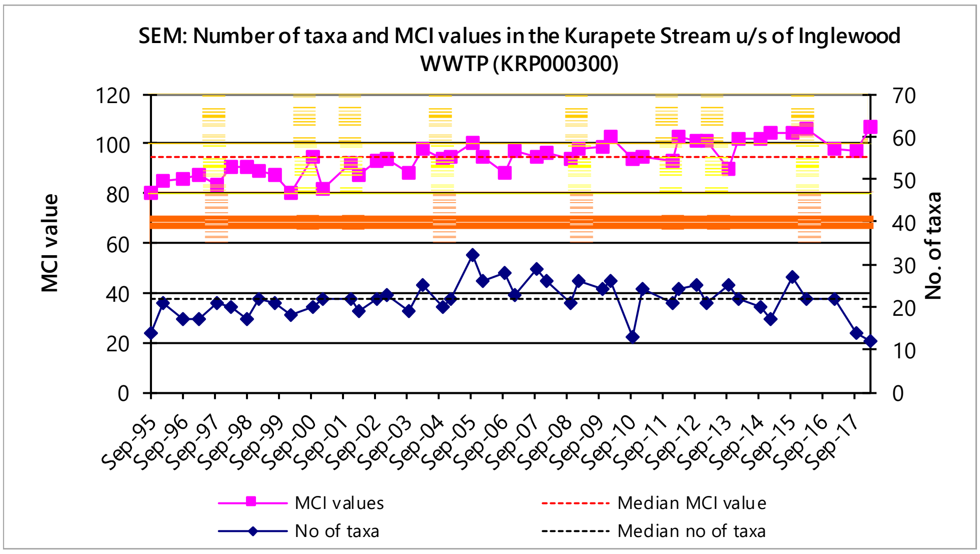


Figure 34 Numbers of taxa and MCI values in the Kurapete Stream upstream of the Inglewood WWTP

A relatively wide range of richness (13 to 32 taxa) has been found with a moderate median richness of 22 taxa, relatively typical of richness in the mid reaches of ringplain streams rising outside the National Park boundary. During the 2017-2018 period spring (14 taxa) and summer (12 taxa) richness was lower than the historical median richness.

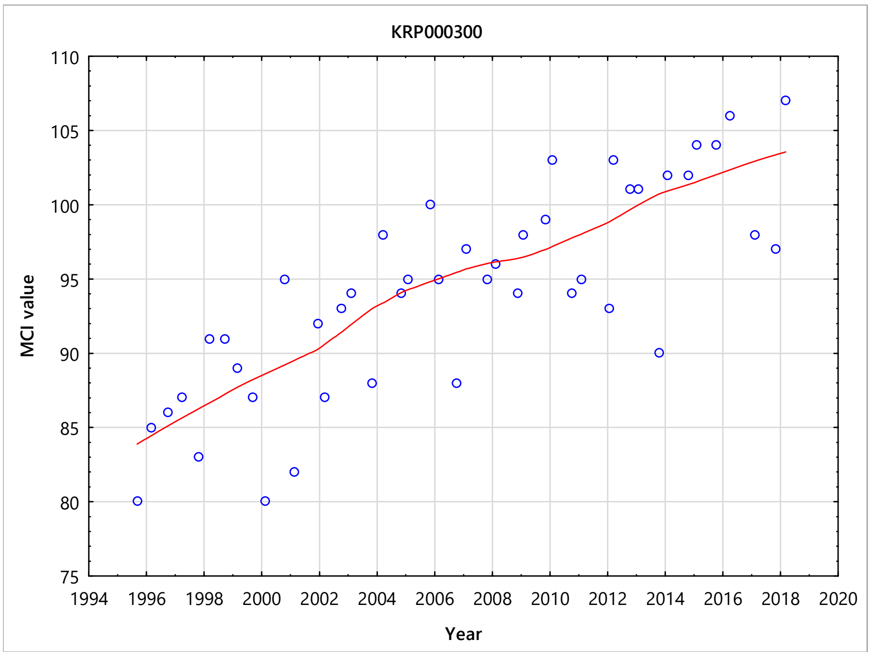
MCI values have had a moderate range (26 units) at this site, typical of mid-reach sites in seepage streams on the ringplain. The spring 2017 (97 units) score was not significantly different to the historical median, while the summer 2018 (107 units) score was significantly higher than the historical median (Stark, 1998). The scores categorised this ringplain seepage stream site as having 'fair' (spring) and 'good' (summer) health generically (Table 3). The historical median score (94 units) placed this site in the 'fair' category for generic health.

3.2.7.1.2 Predicted stream 'health'

The Kurapete Stream rises below the National Park boundary and the site upstream of the Inglewood WWTP is in the mid-reaches at an altitude of 180 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. Again, the historical median and spring scores were both not significantly different to this median value, while the summer score was significantly different to the REC value (Stark, 1998).

3.2.7.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 35). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Kurapete Stream upstream of the Inglewood WWTP.



N = 45
Kendall tau = 0.643
p level < 0.001
FDR p = < 0.001

N = 19
Kendall tau = 0.363
p level = 0.030
FDR p = 0.360

Figure 35 LOWESS trend plot of MCI data in the Kurapete Stream at the site upstream of the Inglewood WWTP for the full datset with Mann-Kenndall tests for the full and ten-year dataset

The very strong positive temporal trend in MCI scores has been highly significant at this site (FDR p < 0.01) immediately upstream of the Inglewood WWTP discharge but below the tributary inflow draining the old Inglewood landfill. This improvement has followed the diversion of the iron-oxide laden drainage out of the stream and into the WWTP system which markedly reduced sediment deposition on the streambed. The strong earlier trend tended to ease between 2004 and 2009 with a subsequent increase in improvement more recently. The overall range of MCI scores across the trendline (19 units) has been ecologically important. The trendline range of MCI scores have been indicative of 'fair' generic stream health throughout the period until recently where it is now of 'good' health.

There was a non-significant postive trend in MCI scores over the most recent ten-year period. The trendline for the most recent ten-year period was indicative of 'fair' health changing to 'good' health since 2013.

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

3.2.7.2.1 Taxa richness and MCI

Forty-three surveys have been undertaken at this lower reach site in the Kurapete Stream 6 km downstream of the Inglewood WWTP outfall (KRP000660) between 1995 and March 2017. These results are summarised in Table 22, together with the results from the current period, and illustrated in Figure 36.

Table 22 Results of previous surveys performed in the Kurapete Stream at the site 6km downstream of the Inglewood WWTP outfall together with the 2017-1018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KRP000660	43	14-30	25	70-112	93	24	101	21	98

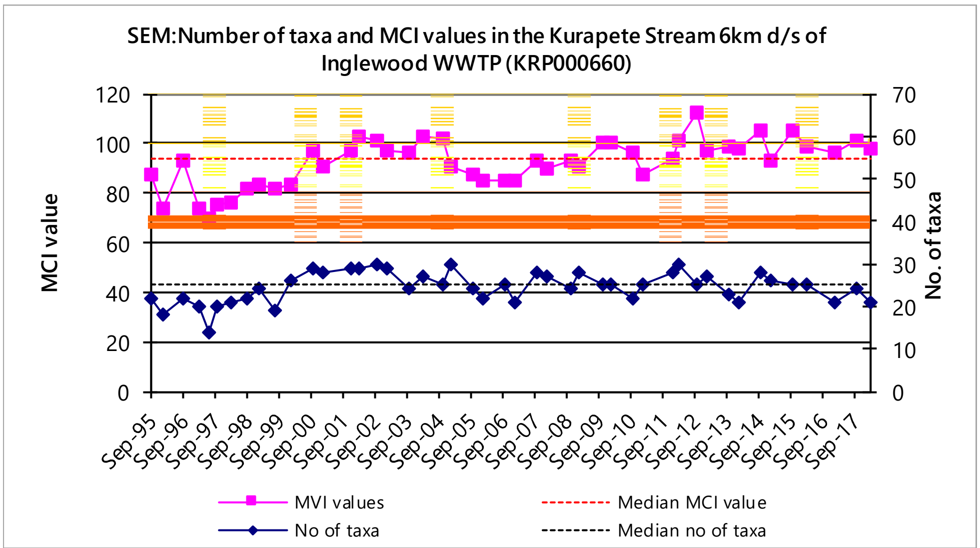


Figure 36 Numbers of taxa and MCI values in the Kurapete Stream, 6 km downstream of the Inglewood WWTP outfall

A moderate range of richness (14 to 30 taxa) has been found, with a median richness of 25 taxa (slightly higher than typical of richness for the lower mid-reaches of ringplain streams rising outside the National Park boundary. During the 2017-2018 period spring (24 taxa) and summer (21 taxa) richness were slightly lower than the historical median.

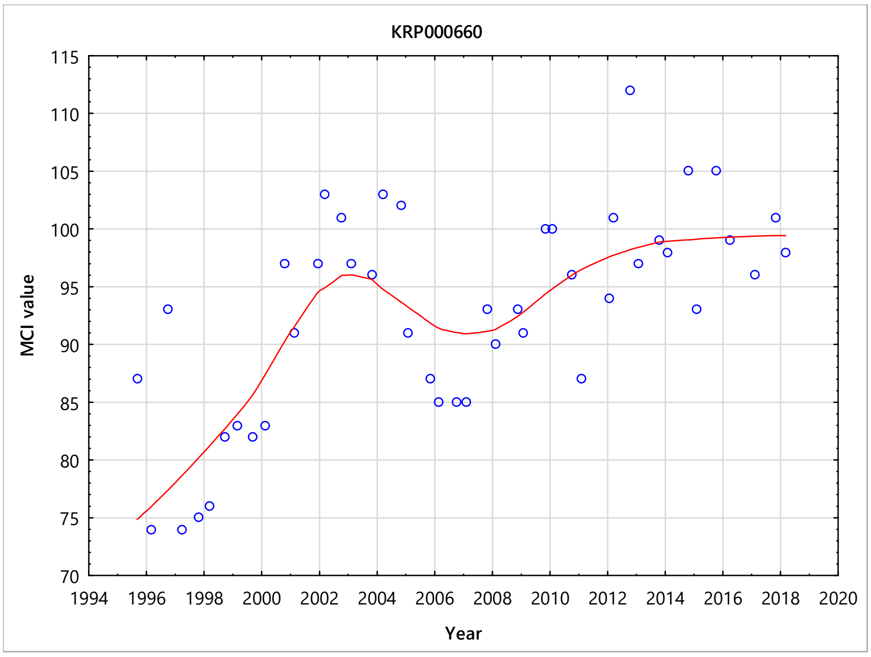
MCI values have had a wide range (42 units) at this site. The median value (93 units) has been typical of lower mid-reach sites in similar seepage-fed streams elsewhere on the ringplain (TRC, 2017b). The sping 2017 (101 units) and summer 2018 (98 units) score was not significantly different to the historical median (Stark, 1998). These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (93 units) placed this site in the 'fair' category for generic health.

3.2.7.2.2 Predicted stream 'health'

The Kurapete Stream rises below the National Park boundary and the site 6 km downstream of the Inglewood WWTP outfall is in the lower mid-reaches at an altitude of 120 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 102 units and therefore the historical median and summer scores were not significantly different from this value (Stark, 1998).

3.2.7.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 37). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Kurapete Stream at the site six km downstream of the Inglewood WWTP outfall.



N = 45
Kendall tau = 0.435
p level < 0.001
FDR p < 0.001

N = 19
Kendall tau = 0.215
p level = 0.198
FDR p = 0.490

Figure 37 LOWESS trend plot of MCI data in the Kurapete Stream for the site 6 km downstream of the Inglewood WWTP outfall for the full dataset with Mann-Kendall test for the full and ten-year dataset

There has been a highly significant positive trend of MCI score improvement (FDR $p < 0.01$). There was a noticeably increase in the steepness of the trend after 2000 (following diversion of all Inglewood WWTP wastes out of the stream (to the New Plymouth WWTP) which was emphasised by an ecologically important increase in score of 24 units. A decreasing trend in scores has been followed by a steady recovery since 2007 coincident with relatively few consented municipal wastes short-duration discharge overflows to the stream during recent years. Overall, the trendline scores indicated improving stream health from 'poor' to 'fair' indicative of the positive effects of diversion of the Inglewood WWTP discharge out of the stream.

There was a non-significant postive trend in MCI scores over the most recent ten-year period even though there was a relatively large increase in the trendline from 2008 to 2014. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.7.3 Discussion

MCI scores generally indicated that both sites had 'good' to 'fair' macrinvertebrate health with little difference between the two sites. MCI scores were typical for the two sites with little difference from historical medians apart from the upper site having a higher than normal summer score, a new maximum for the site by one unit.

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

3.2.8 Maketawa Stream

The Maketawa Stream is a ringplain stream with a source inside Egmont National Park that flows in an easterly direction into the Manganui River. Two sites, originally surveyed as components of the Maketawa catchment baseline investigation (Stark, 2003), were included in the 2002-03 SEM programme in recognition of the fisheries significance of this sub-catchment of the Manganui River catchment. The results from the surveys performed in the 2017-2018 monitoring year are presented in Table 83 and Table 84 Appendix I.

3.2.8.1 Derby Road site (MKW000200)

3.2.8.1.1 Taxa richness and MCI

Thirty-four surveys have been undertaken at this upper reach site in the Maketawa Stream between March 1998 and February 2017. These results are summarised in Table 23 together with the results from the current period, and illustrated in Figure 38.

Table 23 Results of previous surveys performed in the Maketawa Stream at Derby Road together with 2017-2018 results

Site code	SEM data (1998 to Feb 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MKW000200	34	8-33	23	100-142	129	23	131	20	124

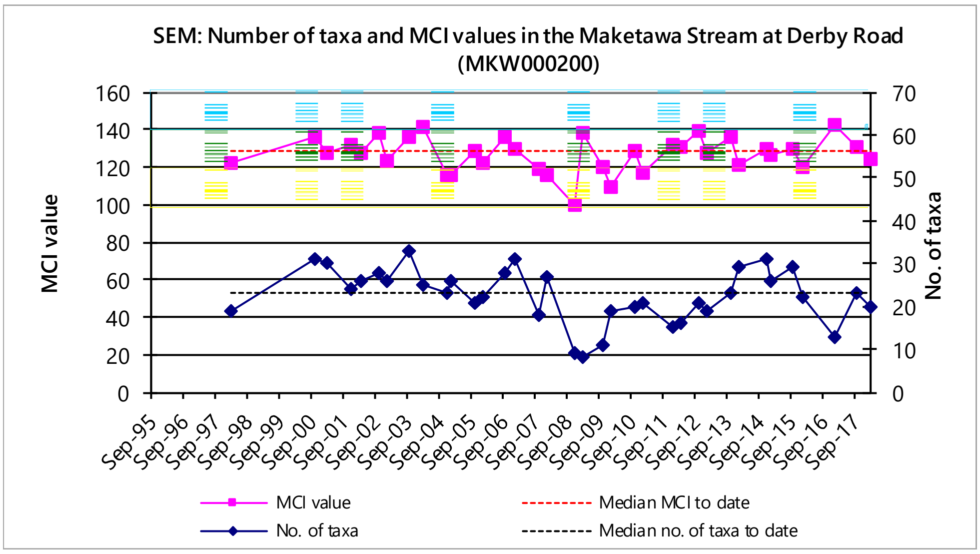


Figure 38 Number of taxa and MCI values in the Maketawa Stream at Derby Road

A very wide range of richness (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 richness found in the upper reaches of ringplain streams and rivers). During the 2017-2018 period, spring (23 taxa) and summer (20 taxa) richness were similar to the previously recorded median.

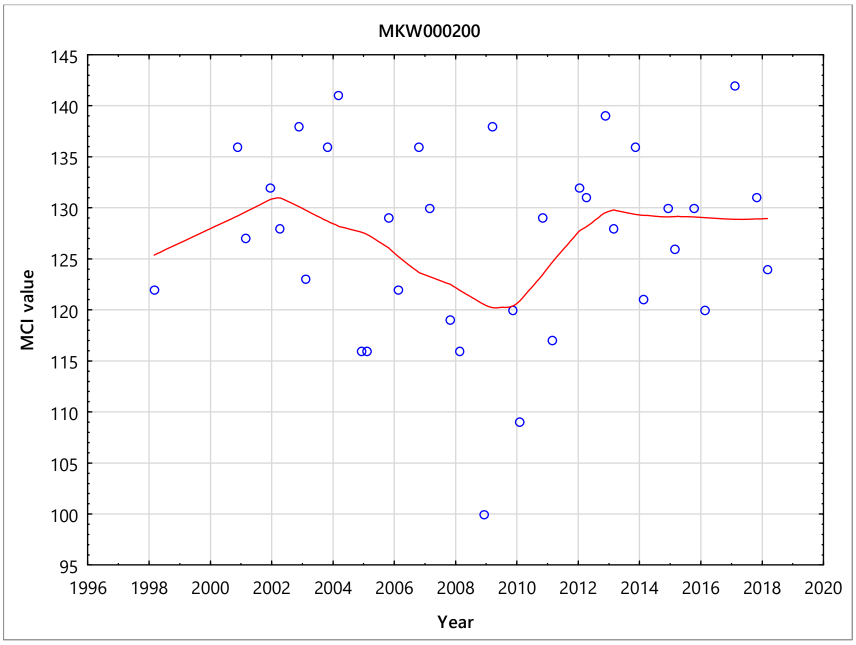
MCI values have had a very wide range (42 units) at this site, atypical of a site in the upper reaches of a ringplain stream mainly due to headwater erosion effects referenced above. The median value (129 units) however, has been more typical of upper reach sites elsewhere on the ringplain. The spring 2017 (131 units) and summer 2018 (124 units) scores were not significantly different (Stark, 1998) to the historical median. The score categorised this site as having 'very good' generic health (Table 3) in spring and summer. The historical median score (129 units) placed this site in the 'very good' category for generic health.

3.2.8.1.2 Predicted stream 'health'

The Maketawa Stream site at Derby Road is 2.3 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 121 for this site. The historical site median (129 units), and the spring and summer scores were not significantly higher than the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 130 units. The historical site median, spring and summer scores were also not significantly different to this value.

3.2.8.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 39). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 20 years of SEM results (1998-2018) and the most recent ten-years of results (2008-2018) from the site in the Maketawa Stream at Derby Road.



N = 36
Kendall tau = 0.011
p level = 0.923
FDR p = 0.940

N = 19
Kendall tau = 0.165
p level = 0.323
FDR p = 0.590

Figure 39 LOWESS trend plot of MCI data at the Derby Road site, Maketawa Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

No significant trend in MCI scores has been found over the 20-year monitoring period at this relatively pristine site. Scores decreased following the headwater erosion events, prior to recovery over the more recent five-year period. The variability in the trendline (range 12 units) represented some ecological importance during the period accentuated by the impact of headwater erosion events during 2008. Overall, the trendline remained indicative of 'very good' generic stream health for the majority of the period, dropping toward 'good' health briefly between 2008 and 2010.

There was a non-significant postive trend in MCI scores over the most recent ten-year period, congruent with the full dataset, even though there was a relatively large increase in the trendline from 2010 to 2013. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.8.2 Tarata Road site (MKW000300)

3.2.8.2.1 Taxa richness and MCI

Thirty-three surveys have been undertaken at this mid-reach site at Tarata Road in the Maketawa Stream between March 2000 and February 2017. These results are summarised in Table 24, together with the results from the current period, and illustrated in Figure 40.

Table 24 Results of previous surveys performed in the Maketawa Stream at Tarata Road together with 2017-2018 results

Site code	SEM data (2000 to Feb 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MKW000300	33	12-31	22	90-119	107	19	127	24	113

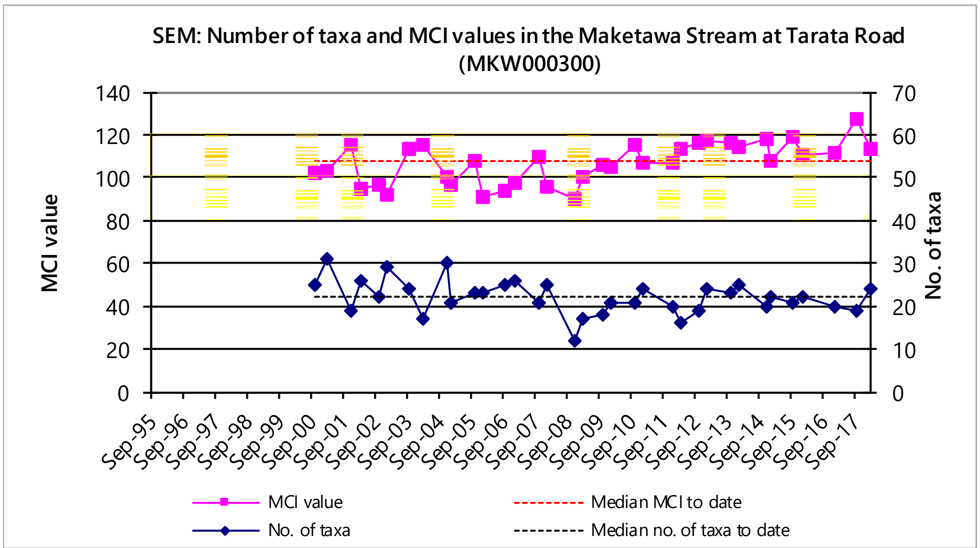


Figure 40 Number of taxa and MCI values in the Maketawa Stream at Tarata Road

A wide range of richness (12 to 31 taxa) has been found; wider than might be expected, with a median richness of 22 taxa which is more representative of typical richness in the mid-reaches of ringplain streams and rivers. During the 2017-2018 period, spring (19 taxa) and summer (24 taxa) richness was similar to the median taxa number. MCI scores have had a relatively wide range (29 units) at this site, more typical of sites in the mid to lower reaches of ringplain streams. The median value (107 units) has been relatively typical of mid-reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (127 units) score was the highest score recorded at this site to date by eight units, and was a significant twenty units higher than the historical median (Star, 1998). The summer 2018 (113 units) score was within the range typical for the site and not significantly different to the historical median (Stark, 1998). The scores categorized this site as having 'very good' (spring) and 'good' (summer) health generically (Table 3). The historical median score (107 units) also placed this site in the 'good' category for generic health.

3.2.8.2.2 Predicted stream 'health'

The Maketawa Stream site at Tarata Road is 15.5 km downstream of the National Park boundary at an altitude of 150 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 101 for this site. The historical site median (107 units) is six units above the predictive distance value. The spring (127 units) and summer (112 units) scores were significantly higher than the distance predictive score. The REC predicted MCI value (Leathwick, et al. 2009) was 111 units. The historical site median and summer scores were also not significantly different to this value, while the springscore was again signifcanatly higher than this value.

3.2.8.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 41). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 18 years of SEM results (2000-2018) and the most recent ten-years of results (2008-2018) from the site in the Maketawa Stream at Tarata Road.

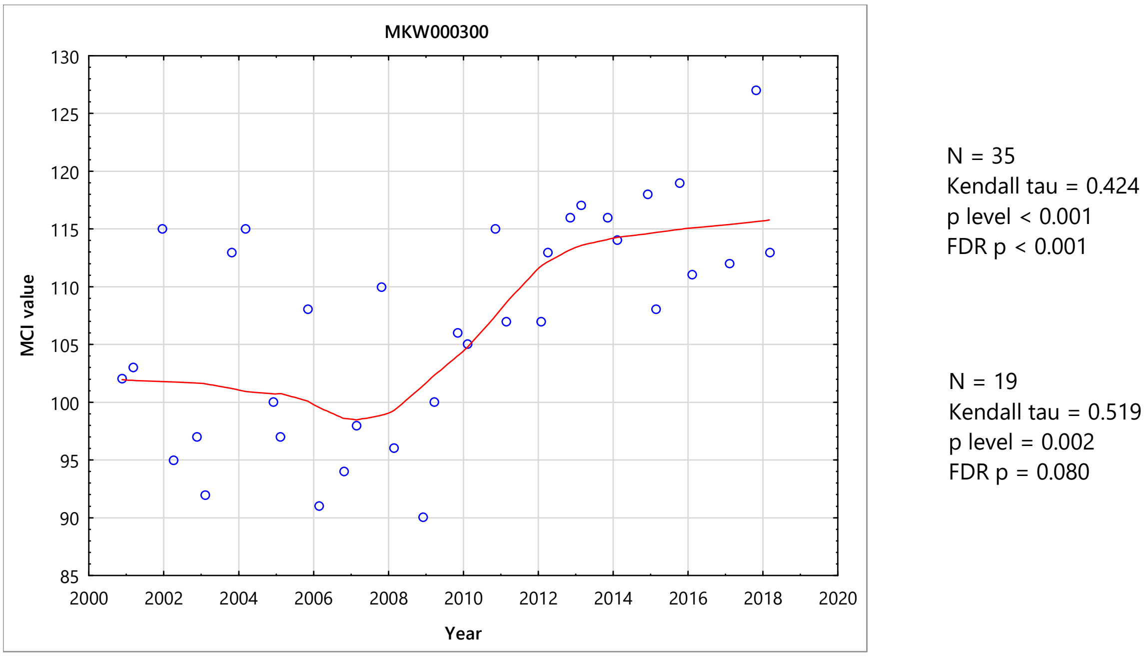


Figure 41 LOWESS trend plot of MCI data at the Tarata Road site for the full dataset with Mann-Kendall test for the full and ten-year dataset

The positive trend in MCI scores found over the 18 year monitoring period has been statistically significant (FDR $p < 0.01$). Ecological variability, which have ranged over 18 units, has been important ecologically with scores indicative of 'good' generic stream health (Table 3) trending downward to 'fair' stream health, between 2006 and 2008 before returning to 'good' health where it currently remains.

There was a non-significant postive trend in MCI scores over the most recent ten-year period, congruent with the full dataset, even though there was a relatively large increase in the trendline from 2008 to 2014. The trendline for the most recent ten-year period was indicative of 'good' health.

3.2.8.3 Discussion

Both sites had typical, moderate, taxa richness. MCI scores at the upper Maketawa Stream site indicated that the macroinvertebrate community was in 'very good' health. The lower Maketawa Stream site MCI score indicated 'very good' to 'good' macroinvertebrate health. There was little difference between sites in the spring survey but there was a significant decrease in a downstream direction in the summer survey but only by 11 units. This was smaller than the usual 22 unit difference between historical medians.

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

3.2.9 Mangaehu River

The Mangaehu River is a large eastern hill country river and is a major tributary of the Patea River. There is one SEM site located on the Mangaehu River in its lower reaches. The results found by the 2017-2018 surveys are presented in Table 85, Appendix I.

3.2.9.1 Raupuha Road site (MGH000950)

3.2.9.1.1 Taxa richness and MCI

Forty-four surveys have been undertaken at this lower reach site in the Mangaehu River between October 1995 and March 2017. These results are summarised in Table 25, together with the results from the current period, and illustrated in Figure 42.

Table 25 Results of previous surveys performed in the Mangaehu River at Raupuha Road, together with 2017-2018 results

Site code	SEM data (1995 to Mar 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGH000950	44	12-26	20	77-104	92	16	104	20	92

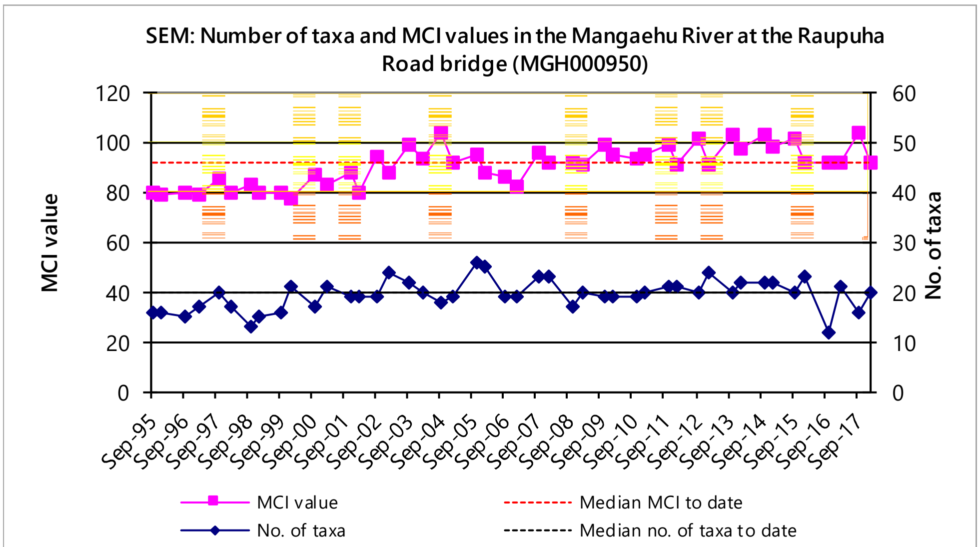


Figure 42 Numbers of taxa and MCI values in the Mangaehu River at Raupuha Road

A relatively wide range of richness (12 to 26 taxa) has been found with a moderate median richness similar to richness in the lower reaches of hill country rivers, although generally at lower altitudes (TRC, 2017b).

During the 2017-2018 period, spring (16 taxa) taxa richness was four taxa less than the historical median. In contrast, summer (20 taxa) richness was equal to the historical median.

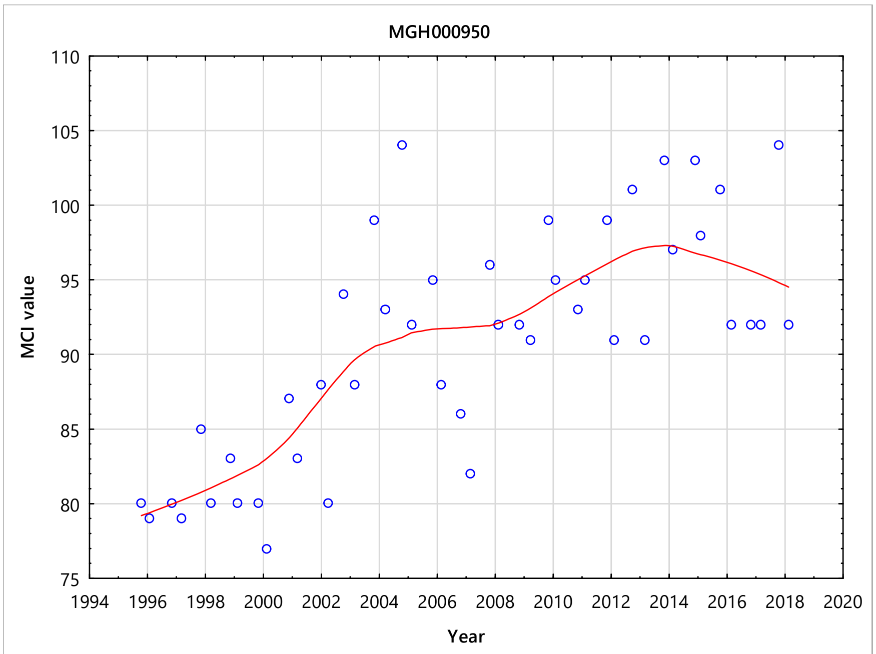
MCI values have had a relatively wide range (27 units) at this site more typical of a site in the lower reaches of streams and rivers. The median value (92 units) has been typical of lower reach sites. The spring 2017 (104 units) was equal to the highest score recorded at this site to date, and was significantly higher than the historical median, while the summer 2018 (92 units) score was identical to the historical median. These scores categorised this site as having 'good (spring) and'fair' (summer) health generically (Table 3). The historical median score (92 units) placed this site in the 'fair' category for the generic method of assessment.

3.2.9.1.2 Predicted stream 'health'

The Mangaehu River site at Raupuha Road, at an altitude of 120 m asl, is in the lower reaches of a river draining an eastern hill country catchment. The REC predicted MCI value (Leathwick, et al. 2009) was 117 units. The historical median, spring and summer scores were all significantly lower than this value.

3.2.9.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 43). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Mangaehu River at Raupuha Road.



N = 46
Kendall tau = 0.535
p value < 0.001
FDR p < 0.001

N = 20
Kendall tau = 0.138
p value = 0.395
FDR p = 0.630

Figure 43 LOWESS trend plot of MCI data for the Raupuha Road site, Mangaehu River for the full datset with Mann-Kendall test for the full and ten-year dataset

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

There was a non-significant postive trend in MCI scores over the most recent ten-year period with a decline in the trendline from 2014 onwards. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.9.2 Discussion

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

3.2.10 Manganui River

The Manganui River is a ringplain river whose source is inside Egmont National Park and is a significant tributary of the Waitara River. There are two SEM sites located on the river, one at its mid reaches and another at its lower reaches. The results found by the 2017-2018 surveys are presented in Table 86 and Table 87.

3.2.10.1 State Highway 3 site (MGN000195)

3.2.10.1.1 Taxa richness and MCI

Forty-four surveys have been undertaken at this mid reach site in the Manganui River between September 1995 and March 2017. These results are summarised in Table 26 together with the results from the current period, and illustrated in Figure 65.

Table 26 Results of previous surveys performed in the Manganui River u/s of railway bridge (SH 3), together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGN000195	44	9-26	21	106-143	126	16	126	20	121

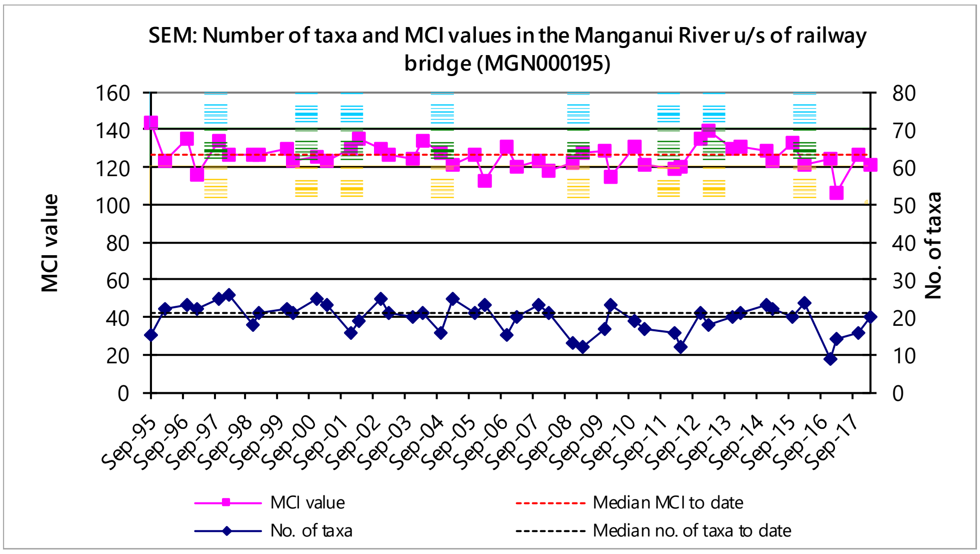


Figure 44 Numbers of taxa and MCI values in the Manganui River above the railway bridge (SH3)

A wide range of richness (9 to 26 taxa) has been found, with a median richness of 21 taxa which was slightly lower than typical richness in the mid-reaches of ringplain streams and rivers, (TRC, 2017b). During the 2017-2018 period richness were moderately low for the site with the spring (16 taxa) and summer (20 taxa) richness up to five taxa lower than the historical median.

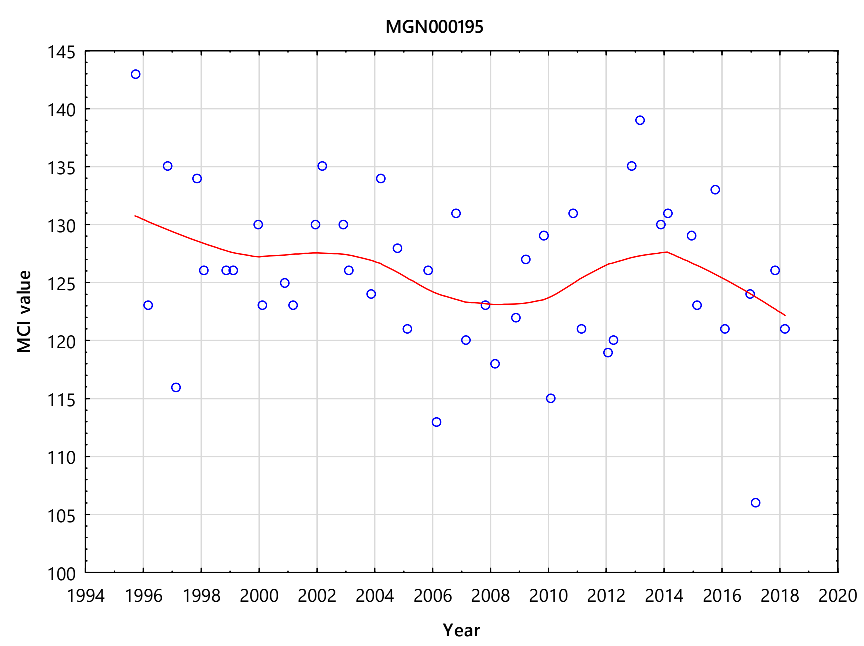
MCI values have had a relatively wide range (37 units) at this site, slightly wider than typical for a site in the mid reaches of a ringplain stream. The median value (126 units) was higher than has been typical of similar mid-reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (126 units) and summer (121 units) scores were not significantly different to the historical median. These scores show some improvement from the previous year, which recorded the lowest taxa richness and lowest MCI score to date at this site. These scores categorised this site as having 'very good' health generically (Table 3) in spring and summer. The historical median score (126 units) placed this site in the 'very good' generic health.

3.2.10.1.2 Predicted stream 'health'

The Manganui River site at SH3 is 8.7 km downstream of the National Park boundary at an altitude of 330 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 107 for this site. The historical site median (126 units) is a significant (Stark, 1998) 19 units above the distance predictive value. The spring 2017 survey (126 units) and summer 2018 (121 units) scores were significantly higher by 19 and 14 units than the predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 124 units. The historical site median, spring and summer scores were not significantly different to this value.

3.2.10.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 45). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Manganui River at SH3.



N = 46
Kendall tau = -0136
p level = 0.181
FDR p = 0.250

N = 20
Kendall tau = -0.037
p level = 0.818
FDR p = 0.860

Figure 45 LOWESS trend plot of MCI data at the SH3 site, Manganui River

A very slight overall decrease in MCI scores was identified (more accentuated over the first 12 years) which was not statistically significant for the 23-year period. The scores (range of nine units) represented no ecological importance in terms of variability. These trendline consistently indicated 'very good' generic river health over the entire period.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, congruent with the full dataset. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.10.2 Bristol Road site (MGN000427)

3.2.10.2.1 Taxa richness and MCI

Forty-four surveys have been undertaken at this lower reach site at Bristol Road in the Manganui River between October 1995 and March 2017. These results are summarised in Table 27 together with the results from the current period, and illustrated in Figure 46.

Table 27 Results of previous surveys performed in the Manganui River at Bristol Road together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Taxa no	Taxa no	Median	Taxa no	MCI	Taxa no	MCI
MGN000427	44	14-26	20	77-115	98	15	117	22	91

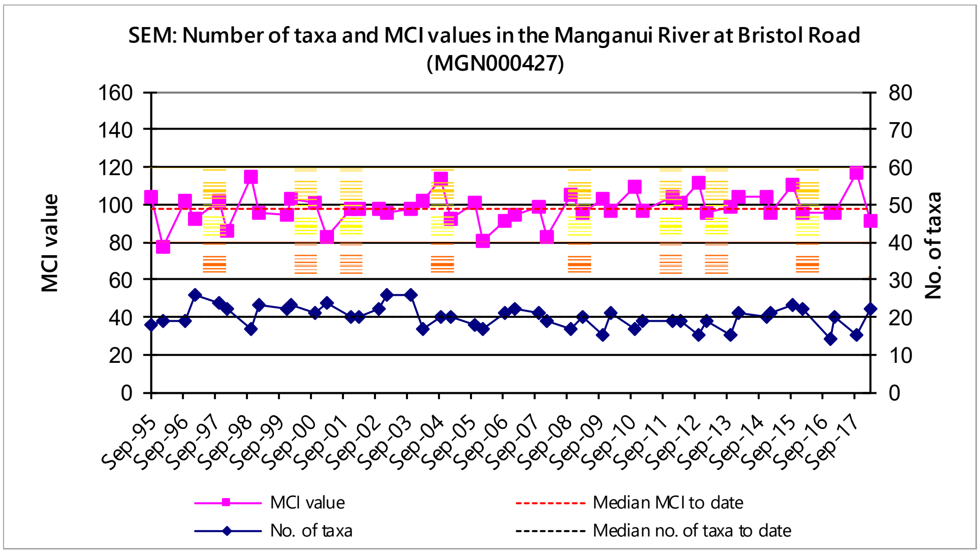


Figure 46 Numbers of taxa and MCI values in the Manganui River at Bristol Road

A moderate range of richness (14 to 26 taxa) has been found with a median richness of 20 taxa which is representative of typical richness in ringplain streams and rivers in the lower reaches. During the 2017-2018 period, the spring (15 taxa) richness was slightly lower than the historical median and the summer (22 taxa) richness was slightly higher than the historical median.

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, 2017b). The spring 2017 score (117 units) was significantly higher than historical median and was the highest score recoded at this site to date, while the summer score (91 units) was similar to the historical median. These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (98 units) placed this site in the 'fair' category for generic health.

3.2.10.2.2 Predicted stream 'health'

The Manganui River site at Bristol Road is 37.9 km downstream of the National Park boundary at an altitude of 140 m asl. Relationships for ringplain streams developed between MCI and distance from the National park boundary (Stark and Fowles, 2009) predict a MCI value of 91 for this site. The historical site median and summer scores were not significantly different to the predictive value, while the spring score was significnalty higher (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 103 units. The historical site median was not significantly different to the REC predictive value, while the spring score was significantly higher and the summer score was significantly lower.

3.2.10.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 47). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Manganui River at Bristol Road.

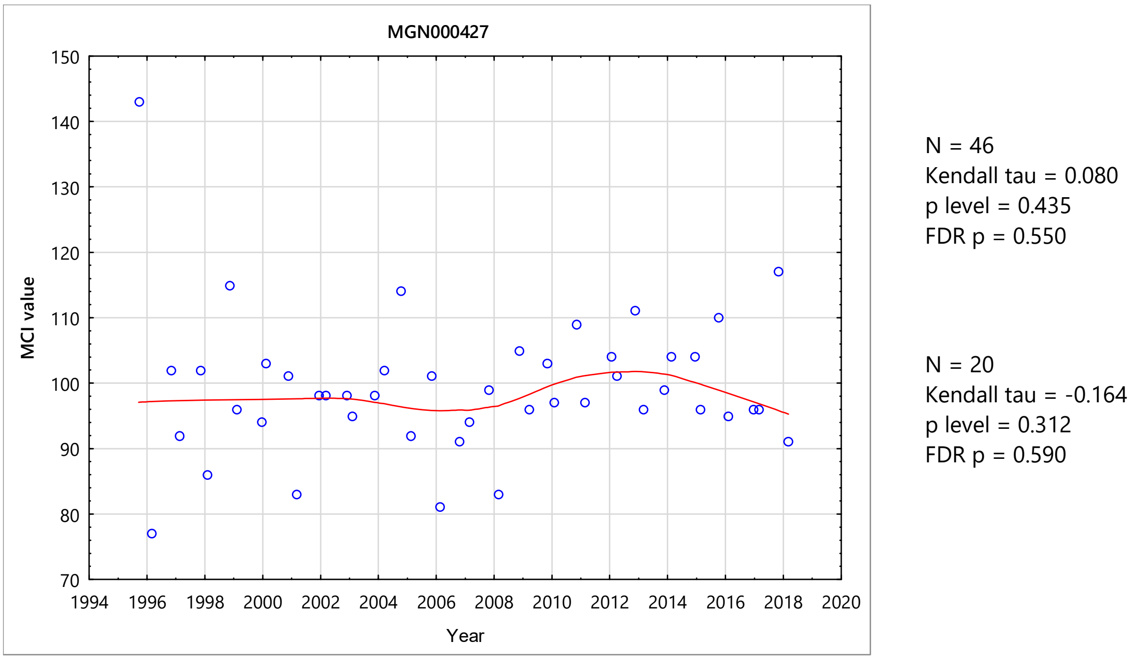


Figure 47 LOWESS trend plot of MCI data at the Bristol Road site, Manganui River

The slight overall positive trend in MCI scores was not statistically significant and neither has the ecological variability in the trendline of seven units been of ecological importance. The trendline was indicative of 'fair' generic river health at this site throughout the majority of 23-year period.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, in constrast with the full dataset, with a decline in the trendline from 2013 onwards. The trendline for the most recent ten-year period was indicative of 'fair' health with a brief period of 'good' health between 2010 and 2015.

3.2.10.3 Discussion

The Manganui River had typical taxa richness. MCI scores were also typical except for a record high score at the lower site for spring by two units. MCI scores indicated that the upper site was in 'very good' health while the lower site was 'good' to 'fair' health. MCI score typically fell in a downstream direction in both spring (by only 9 units) and summer (by 30 units), over a stream distance of 29.2 km downstream from the National Park boundary. Based on the long-term median SEM MCI scores for both sites the score fell in a downstream direction by 28 units.

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

3.2.11 Mangaoraka Stream

The Mangaoraka Stream is a ringplain stream whose source is outside Egmont National Park. The stream flows in a northerly direction and is a tributary of the Waiongna Stream where it joins close to the coast. A single site is surveyed. The results found by the 2017-2018 surveys are presented in Table 88, Appendix I.

3.2.11.1 Corbett Road site (MRK000420)

3.2.11.1.1 Taxa richness and MCI

Forty-three surveys have been undertaken at this lower reach site in the Mangaoraka Stream between October 1995 and February 2017. These results are summarised in Table 28, together with the results from the current period, and illustrated in Figure 48.

Table 28 Results of previous surveys performed in Mangaoraka Stream at Corbett Road, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Taxa no	Taxa no	Median	Taxa no	MCI	Taxa no	MCI
MRK000420	43	11-30	25	75-105	90	19	97	18	84

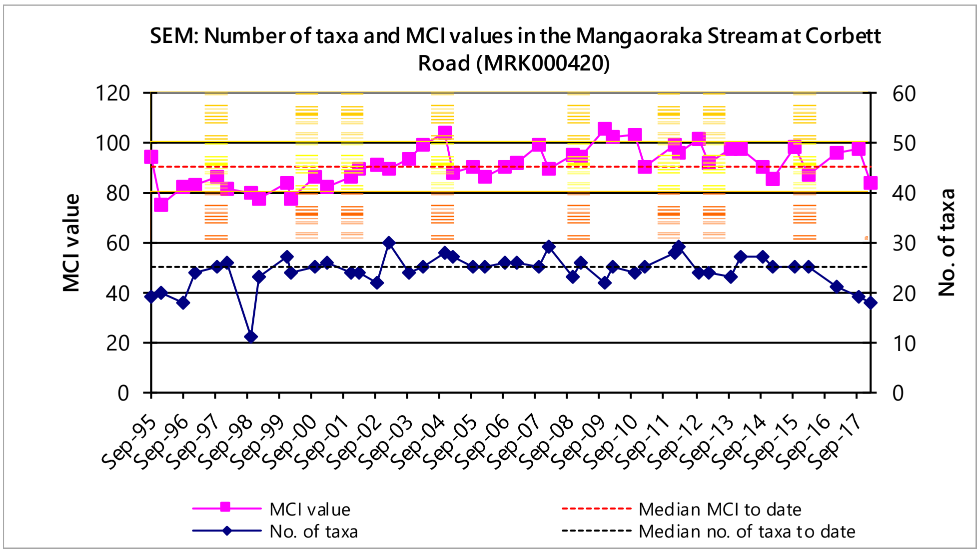


Figure 48 Numbers of taxa and MCI values in the Mangaoraka Stream at Corbett Road

A wide range of richness (11 to 30 taxa) has been found, with a median richness of 25 taxa (more representative of typical richness in the lower reaches of ringplain streams rising outside the National Park boundary). During the 2017-2018 period spring (19 taxa) and summer (18 taxa) richness was lower than historical median richness, by six and seven taxa respectively.

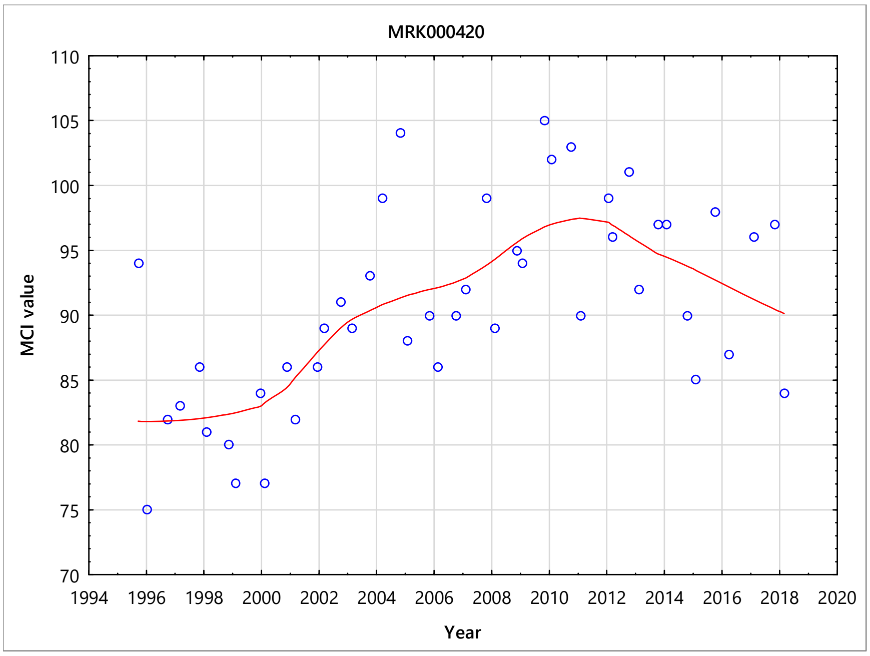
MCI values have also had a relatively wide range (30 units) at this site to date. The median value (90 units) has been typical of lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (97 units) and summer 2018 score (84 units) was not significantly different to the historical median and categorised this site as having 'fair' health generically (Table 3). The historical median score (90 units) placed this site in the 'fair' generic health.

3.2.11.1.2 Predicted stream 'health'

The Mangaoraka Stream rises below the National Park boundary and the site at Corbett Road is in the lower reaches at an altitude of 60 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical site median, spring and summer scores were also not significantly different to this value.

3.2.11.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 49). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Mangaoraka Stream at Corbett Road.



N = 45
Kendall tau = 0.402
p level < 0.001
FDR p < 0.001

N = 19
Kendall tau = -0.332
p level = 0.047
FDR p = 0.360

Figure 49 LOWESS trend plot of MCI data at the Corbett Road site, Mangaoraka Stream for the full datsetwith Mann-Kendall test for the full and ten-year datset

The MCI scores have shown a highly significant improvement (p < 0.01 after FDR). Scores improved from 1995 to 2011 but have since decreased from 2011 to 2018. However, the latest scores remain above most scores recorded prior to 2002. The trendline has varied over an ecologically important range of 16 units during the period. SEM physicochemical monitoring at this site had illustrated significant improvements in aspects of organic loadings at this site in the lower reaches of the stream prior to mid 2008. This was coincident with more rigorous surveillance monitoring of nearby quarrying and waste disposal activities and good dairy shed wastewater disposal compliance performance during that period. The trendline was indicative of 'fair' generic stream health.

There was a non-significant negative trend in MCI scores over the most recent ten-year period after FDR, in constrast with the full dataset, with a decline in the trendline from 2012 onwards. Without FDR application, there was a significant negative trend. Recently, aspects of poorer overall water quality (i.e. increased bacteriological numbers and increasing trends in certain nutrient species) have been recorded (TRC, 2014) which appear to have negatively affected macroinvertebrate communities. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.11.2 Discussion

The site had a slightly lower than usual taxa richness. MCI scores were typical and indicated 'fair' health. The MCI score was also within expected parameters based on median scores and expected values from historical site, regional, and national data. MCI values significantly decreased between spring and summer at this lower reach site by 13 units (Appendix II) indicating little seasonal variation.

The time trend analysis showed a significant postive trend for the full dataset and a non-significant negative trend for the ten-year dataset indicting a significant improvement in macroinvertebrate health over the full duration of monitoring but no significant change and possibly a decline in health more recently.

3.2.12 Mangati Stream

The Mangati Stream is a small, coastal stream flowing south to north. Two sites located above and below an industrial area are sampled for SEM purposes. The results for the 2017-2018 surveys are presented in Table 89 and Table 90.

3.2.12.1 Site downstream of railbrige (MGT000488)

3.2.12.1.1 Taxa richness and MCI

Forty-four 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 March 2017. These are summarised in Table 29, together with the results from the current period, and illustrated in Figure 50.

Table 29 Results of previous surveys performed in the Mangati Stream at the site downstream of the railbridge, together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGT000488	44	9-29	16	56-91	78	14	76	11	71

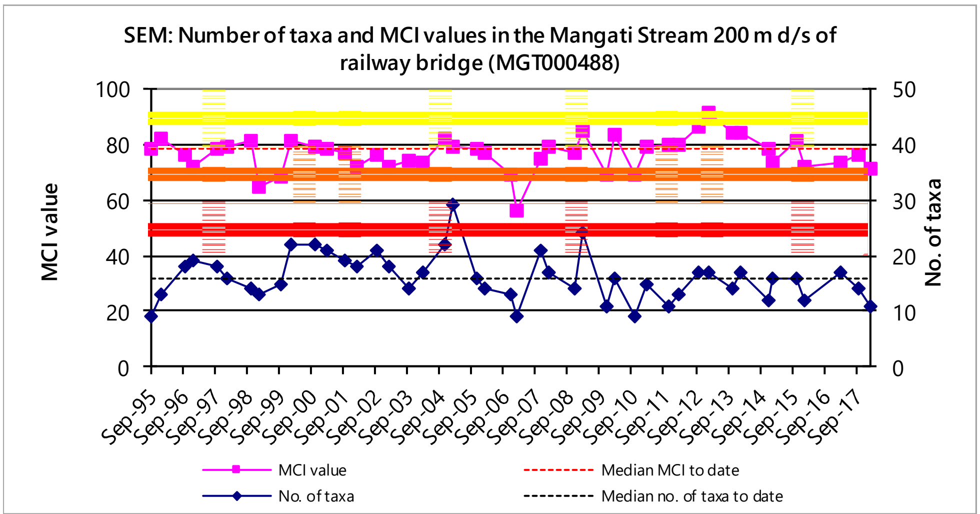


Figure 50 Numbers of taxa and MCI values in the Mangati Stream downstream of the railbridge

A very wide range of richness (9 to 29 taxa) has been found; with a median richness of 16 taxa which was a typical richness in Taranaki lowland coastal streams (TRC, 2017b). During the 2017-2018 period the spring survey (14 taxa) had a taxa richness typical for the site, while the summer survey (11 taxa) had slightly lower than typical richness that was within the previously recorded range at this site.

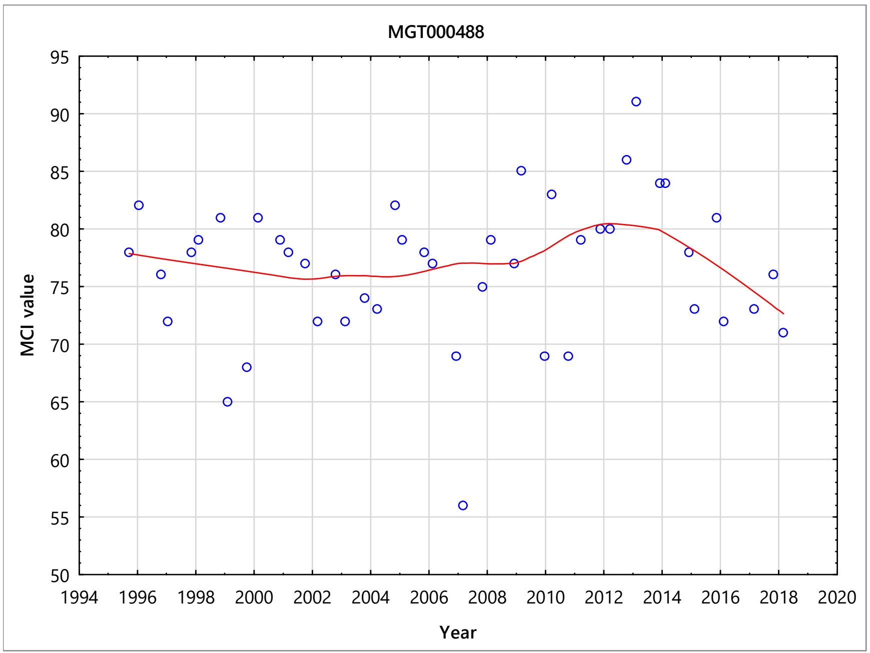
MCI values have had a wide range (35 units) at this site, relatively typical of a site in a small coastal stream. The median historical value (78 units) has also been typical of such streams and the spring 2017 (76 units) and summer 2018 (71 units) score was not significantly different to the historical median (Stark, 1998). These scores categorised this site as having 'poor' health in spring and summer (Table 3). The historical median score (78 units) placed this site in the 'poor' health category for the generic method of assessment.

3.2.12.1.2 Predicted stream 'health'

The Mangati Stream site downstream of the railbridge is in the middle reaches of a small lowland, coastal stream at an altitude of 30 m asl. The median value for lowland coastal streams of similar (TRC, 2017b) was a very low 68 units. The historical site median, spring and summer scores were not significantly different to this value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 80 units. The historical site median was significantly lower than this value, while the spring and summer scores were not significantly different to this value.

3.2.12.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 51). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Mangati Stream at the site downstream of the railbridge.



N = 45
Kendall tau = 0.065
p level = 0.535
FDR p = 0.650

N = 19
Kendall tau = -0.160
p level = 0.339
FDR p = 0.600

Figure 51 LOWESS trend plot of MCI data at the Mangati Stream site downstream of the railbridge for the full dataset with Mann-Kendall test for the full and ten-year dataset

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

There was a non-significant negative trend in MCI scores over the most recent ten-year period after FDR, in constrast with the full dataset, with a decline in the trendline from 2012 onwards, probably as a result of increased earthworks upstream of the site. The trendline for the most recent ten-year period was indicative of 'poor' health.

3.2.12.2 Te Rima Place, Bell Block site (MGT000520)

3.2.12.3 Taxa richness and MCI

Forty-four surveys have been undertaken at this lower reach site at SH45 in the Mangati Stream between October 1995 and March 2017. These results are summarised in Table 30, together with the results from the current period, and illustrated in Figure 52.

Table 30 Results of previous surveys performed in the Mangati Stream at Te Rima Place, Bell Block together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Taxa no	Taxa no	Median	Taxa no	MCI	Taxa no	MCI
MGT000520	44	3-22	11	44-79	66	5	52	10	76

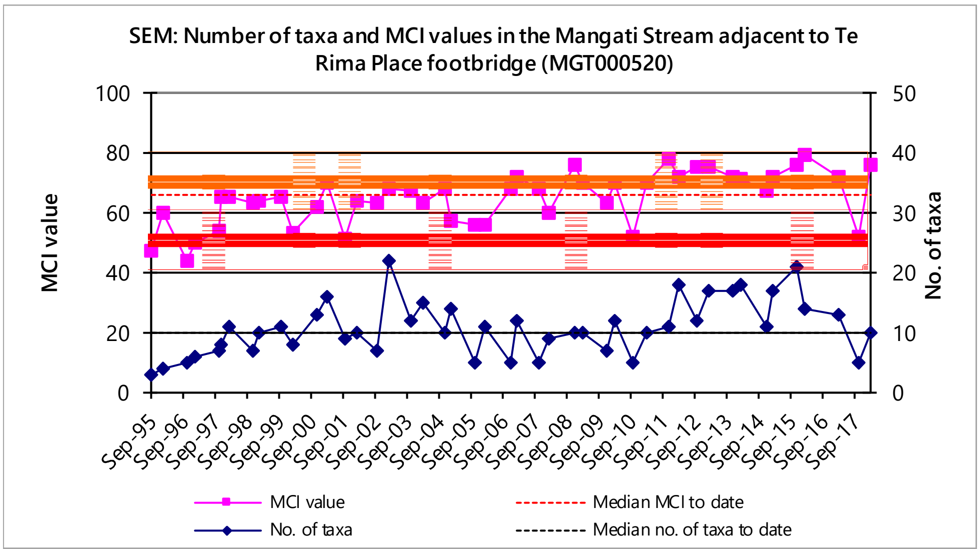


Figure 52 Numbers of taxa and MCI values in the Mangati Stream at Te Rima Place footbridge

A wide range of richness (3 to 22 taxa) has been found; wider than might be expected with a median richness of 11 taxa, lower than typical richness in the lower reaches of small lowland, coastal streams in Taranaki (17 taxa, TRC, 2017b). During the 2017-2018 period, spring (5 taxa) richness was within the ranage previously recorded at this site, but substantially lower than the historc median richness, while summer (10 taxa) richness was similar to the historical median richness.

MCI scores have had a relatively wide range (35 units) at this site, typical of sites in the lower reaches of small lowland, coastal streams. The spring 2017 (52 units) was significantly lower than the historical median, while the summer 2018 (76 units) score was not significantly different to the low historical median of only 66 units. The scores categorised this site as having 'very poor' (spring) and 'poor' (summer) health generically (Table 3). The historical median score (66 units) also placed this site in the 'poor' category for the generic method of assessment.

3.2.12.3.1 Predicted stream 'health'

The Mangati Stream at Te Rima Place, Bell Block is in the lower, more gravel-bottomed reaches of a small lowland, coastal stream at an altitude of 20 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 88 units. The historical site median, spring and summer scores were significantly lower than this value (by 22, 36 and 12 units).

3.2.12.3.2 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 53). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Mangati Stream at Te Rima Place.

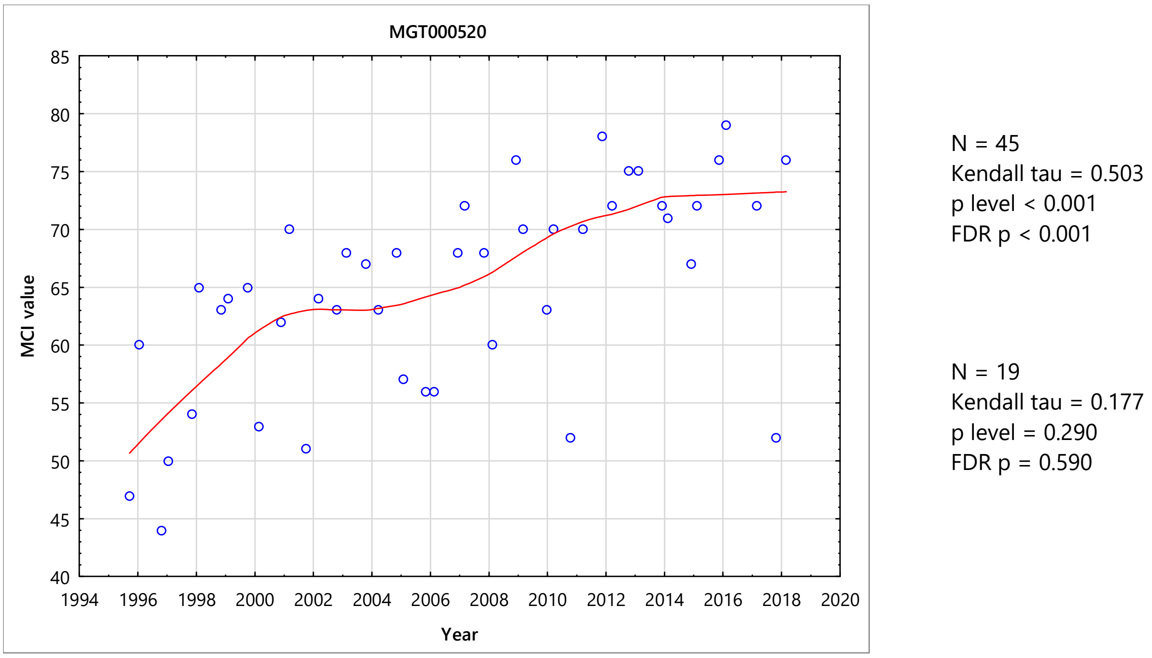


Figure 53 LOWESS trend plot of MCI data at the Mangati stream site at Te Rima Place, Bell Block for the full dataset with Mann-Kendall test for the full and ten-year datset

A positive significant trend in MCI scores has indicated continued improvement coincident with better control and treatment of industrial point source discharges in the catchment and wetland installation (stormwater interception) in the mid catchment with this improvement continuing in recent years. The trendline had a range of scores (22 units) that has been ecologically important with MCI scores indicative of a shift from 'very poor' over the first four years to 'poor' generic stream health during the remaining period.

There was a non-significant positve trend in MCI scores over the most recent ten-year period with the trendline slope starting to flatten out after 2014. The trendline for the most recent ten-year period was indicative of 'poor' health.

3.2.12.4 Discussion

Taxa richness in the upper site were slightly lower than usual, particularly in summer, but the lower site during spring had a very low taxa richness, only five taxa, and appeared to be affected by poor water quality, probably due to an illegal discharge of hydrocarbons upstream of the site.

MCI scores were congruent with taxa richness, the upper site had slightly lower than usual MCI scores, particularly in summer, indicating 'poor' health. The lower site during spring had a very low MCI score, only 52 MCI units, indicative of 'very poor' health, the lowest classification possible, which again was likely due to the discharge of hydrocarbons. The low spring score at the lower site caused a significant decrease (24 units) between the upper and lower sites over a relatively short distance.

The time trend analysis showed no significant trends for the upper site but there was a significant, positive trend at the lower site for the full dataset. This indicates that macroinvertebrate health has been improving at the lower site and suggests that improvements in water quality have largely occurred between the two sites. The lack of a significant trend for the ten-year dataset may be due to the smaller sample size reducing the power to detect significant differences though the very low spring score recorded this monitoring year would also be a contributring factor.

3.2.1 Mangawhero Stream

The Mangawhero Stream is a small stream that arises as a seepage stream draining the Ngaere swamp with a lower sub-catchment (Mangawharawhara Stream) rising on the ringplain but outside of Egmont National Park. Two sites are located on the stream, one above the discharge point of the Eltham WWTP and another close to the where it joins the Waingongoro River. The results found by the 2017-2018 surveys are presented in Table 91 and Table 92, Appendix I.

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

3.2.1.1.1 Taxa richness and MCI

Forty-four 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 2017. These results are summarised in Table 31, together with the results from the current period, and illustrated in Figure 54.

Table 31 Results of previous surveys performed in Mangawhero Stream upstream of Eltham WWTP, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000380	44	10-24	15	58-85	75	13	72	17	64

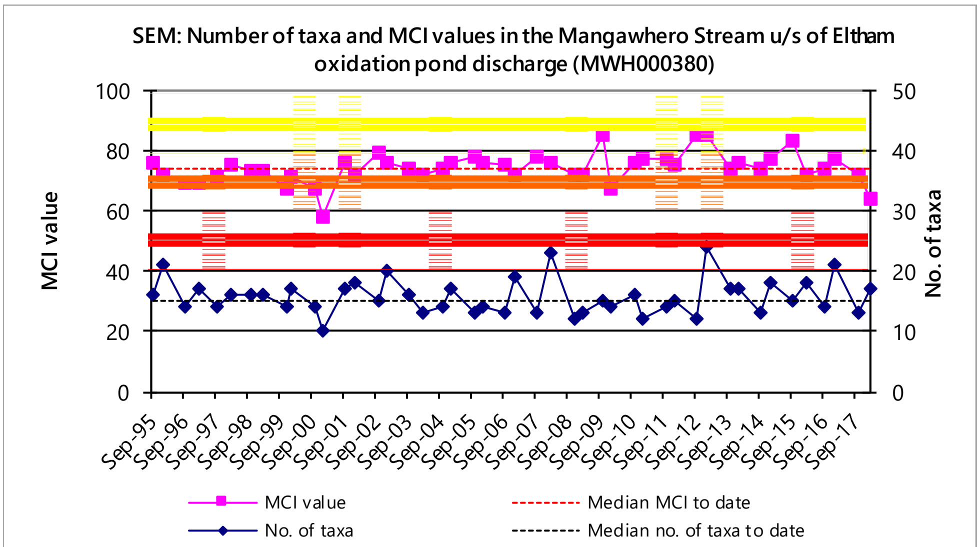


Figure 54 Numbers of taxa and MCI values in the Mangawhero Stream upstream of Eltham WWTP

A moderately wide range of richness (10 to 24 taxa) has been found, with a median richness of 15 taxa (more representative of typical richness in small swamp drainage streams where a median richness of 18 taxa has been found at similar altitudes (TRC, 2017b). During the 2017-2018 period spring (13 taxa) and summer (17 taxa) richness were relatively similar to each other and to the historical median.

MCI values have had a moderate range (27 units) at this site. The median value (75 units) has been typical of similar non-ringplain sites elsewhere in the region. The spring 2017 (72 units) score was not significantly different to the historical median, while the summer 2018 (64 units) score was significantly lower than the historical median (Stark, 1998). These scores categorised this site as having ‘poor’ (spring and summer) health generically (Table 2). The historical median score (75 units) placed this site in the 'poor' category for the generic method of assessment.

3.2.1.1.2 Predicted stream 'health'

The Mangawhero Stream rises as seepage from the Ngaere swamp and is not a ringplain stream at the site upstream of the Eltham WWTP. This site is at an altitude of 200 m asl and toward its upper reaches. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical, spring and summer scores were all significantly lower than the REC predictive value.

3.2.1.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 55). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the 23 years of SEM results (1995-2018) from the site in the Mangawhero Stream upstream of the Eltham WWTP discharge.

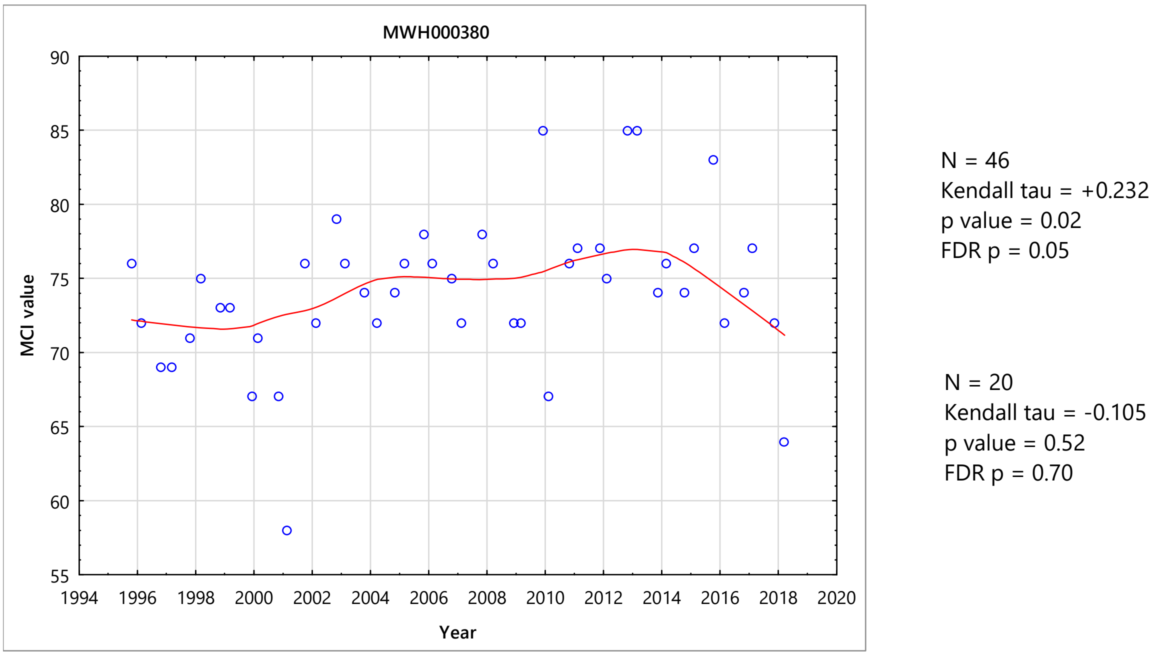


Figure 55 LOWESS trend plot of MCI data at site upstream of the Eltham WWTP discharge, Mangawhero Stream for the full datset with Mann-Kendall test for the full and ten- year dataset

A non-significant (p = 0.05, after FDR) trend in MCI scores has been found over the 23-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 decline in recent years. However, the narrow range of trendline scores (six units) has not been of ecological importance over the monitoring period. Trendline MCI scores consistently have been indicative of 'poor' generic stream health (Table 2) throughout the period.

3.2.1.2 Site downstream of the Mangawharawhara Stream confluence (MWH000490)

3.2.1.2.1 Taxa richness and MCI

Forty-four surveys have been undertaken at this lower mid-reach site in the Mangawhero Stream between October 1995 and February 2017. These results are summarised in Table 32, together with the results from the current period, and illustrated in Figure 56.

Table 32 Results of previous surveys performed in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000490	44	13-30	20	63-102	79	16	88	21	87

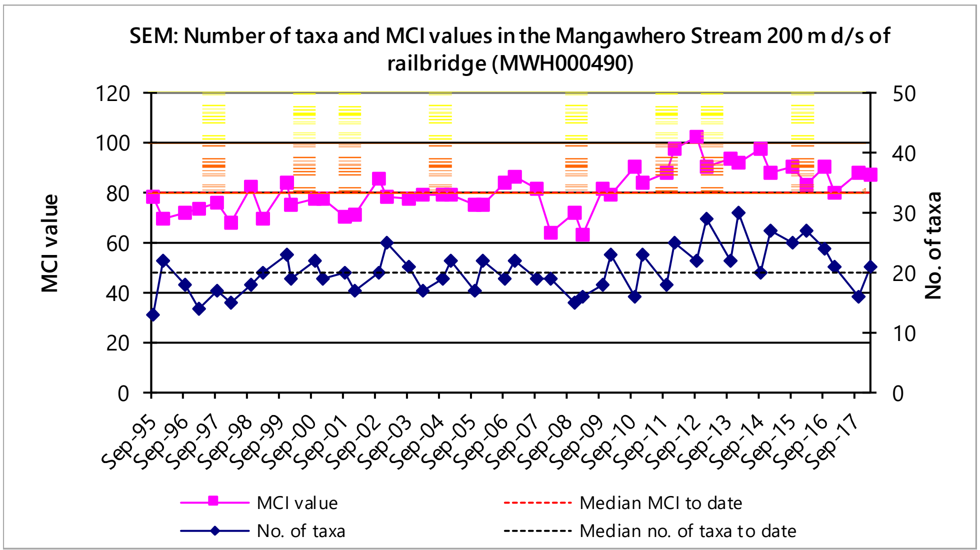


Figure 56 Numbers of taxa and MCI values in the Mangawhero Stream downstream of the railbridge and Mangawharawhara Stream confluence

A relatively wide range of richness (13 to 30 taxa) has been found with a moderate median richness of 20 taxa (more representative of typical richness in the lower-mid reaches of streams and rivers). During the 2017-2018 period spring (16 taxa) and summer (21 taxa) richness were similar to the historical 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 2017 (88 units) and the summer 2018 (87 units) scores were not significantly different to the historical median (Stark, 1998). The MCI scores categorised the site as having 'fair' health generically (Table 2) in both spring and summer. The historical median score (79 units) placed this site in the 'poor' category for generic health.

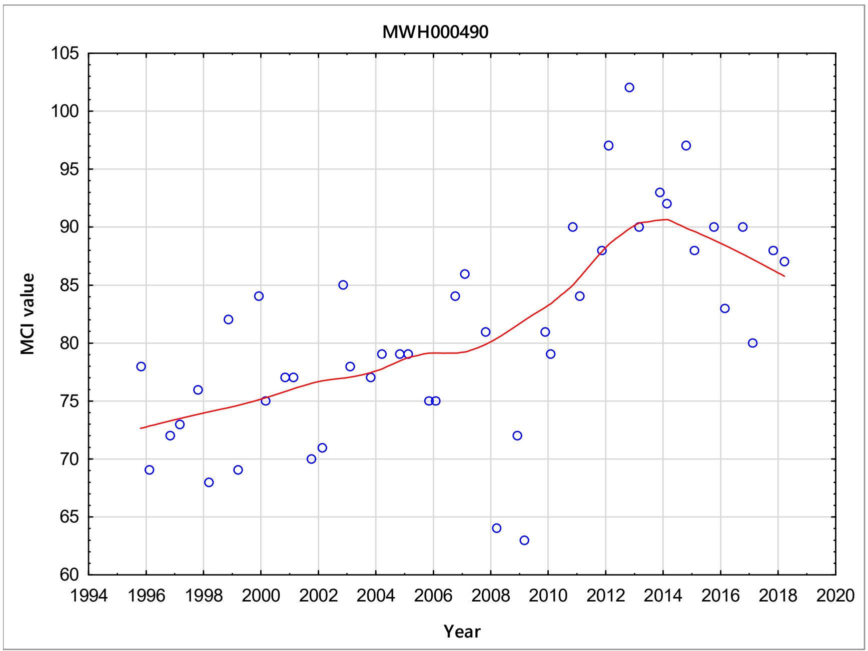
3.2.1.2.2 Predicted stream 'health'

The Mangawhero Stream site below the Mangawharawhara Stream confluence, at an altitude of 190 m asl, is in the lower reaches of a stream draining a catchment comprised of the Ngaere Swamp drainage system and a mid-reach ringplain sub-catchment with its headwaters outside the National Park. The REC predicted MCI value (Leathwick, et al. 2009) was 93 units. The spring and summer scores were not significantly different to this value but the historical median was significantly lower.

3.2.1.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 57). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) from the site in the Mangawhero Stream downstream of the

Mangawharawhara Stream confluence. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend reporting purposes.



N = 46
Kendall tau = +0.482
p value < 0.01
FDR p < 0.01

N = 20
Kendall tau = +0.162
p value = 0.32
FDR p = 0.59

Figure 57 LOWESS trend plot of MCI data at the Mangawhero Stream site downstream of the Mangawharawhara Stream confluence for the full datset with Mann-Kendall test for the full and ten-year dataset

A significant ($p < 0.01$, after FDR) improvement in MCI scores has been illustrated at this more ringplain-like site in the lower reaches of the stream near its confluence with Waingongoro River. The wide range in trendline scores (17 units) has more recently become ecologically important over this 23-year period. Scores have declined over the last four years after a steady improvement between 1995 and 2006 prior to the more recent marked improvement due to improved scores since the diversion of the Eltham WWTP wastes discharge out of the stream in July 2010.

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

3.2.1.3 Discussion

The Mangawhero Stream generally had moderate taxa richness with the upper site typically having slightly lower richness than the lower site due to poorer habitat quality and the current survey results were largely congruent with previous surveys. MCI scores indicated 'poor' health at the upper site and 'fair' health at the lower site. The scores continue to reflect the lowland, swampy, nature of the headwaters of the Mangawhero Stream. MCI scores typically improved in a downstream direction in both spring and summer over a stream distance of 16.5 km between the upper and lower sites of this stream. This was principally as a result of improvement in physical habitat between the two sites.

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

3.2.2 Mangorei Stream

The Mangorei Stream is a ringplain stream and tributary of the Waiwhakaiho River. A site was established in the lower reaches of the Mangorei Stream, near the confluence with the Waiwhakaiho River, for the SEM programme of 2002-2003, in recognition of the importance of this catchment as the only major inflow to the lower reaches of the river below significant HEP and New Plymouth District Council water supply abstractions. The results from the surveys performed in the 2017-2018 monitoring year are presented in Table 93, Appendix I.

3.2.2.1 SH3 site (MGE000970)

3.2.2.1.1 Taxa richness and MCI

Twenty-nine surveys have been undertaken at this lower reach site in the Mangorei Stream between November 2002 and February 2017. These results are summarised in Table 62, together with the results from the current period, and illustrated in Figure 58.

Table 33 Results of previous surveys performed in the Mangorei Stream at SH 3 together with the 2017-2018 results

Site code	SEM data (2002 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGE000970	29	22-33	27	86-113	102	23	105	22	96

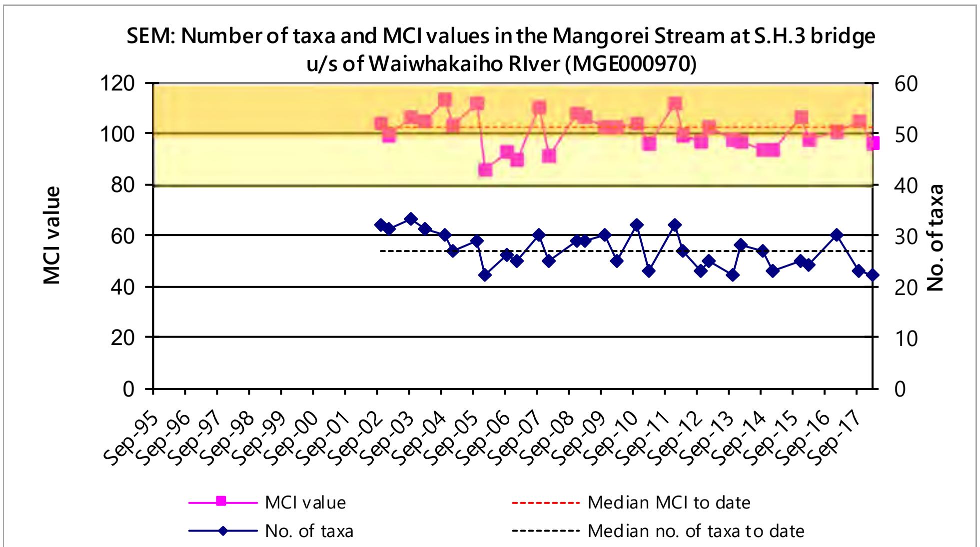


Figure 58 Numbers of taxa and MCI values in the Mangorei Stream at SH3

A moderate range of richness (22 to 33 taxa) has been found with a relatively high median richness of 27 taxa which was more representative of typical richness in upper and middle reaches of ringplain streams and rivers (TRC, 2017b). During the 2017-2018 period, spring (23 taxa) and summer (22 taxa) richness was slightly lower than the historical median richness.

MCI values have had a relatively wide range (27 units) at this site, typical of a site in the lower reaches of a ringplain stream. However, the median value (102 units) has been more typical of mid-reach sites elsewhere on the ringplain. The spring 2017 (105 units) and summer 2018 (96units) scores were similar to the historical median. The scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (102 units) placed this site in the 'good' health category.

3.2.2.1.2 Predicted stream 'health

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

The median value for ringplain streams of similar altitude arising within the National Park (TRC, 2017b) was 102 units. The historical site median, spring and summer scores were similar to this value. The REC predicted MCI value (Leathwick, et al. 2009) was 101 units. The historical site median, spring and summer scores were not significantly different to this value.

3.2.2.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 59). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 16 years of SEM results (2002-2018) from the site in the Mangorei Stream at SH3.

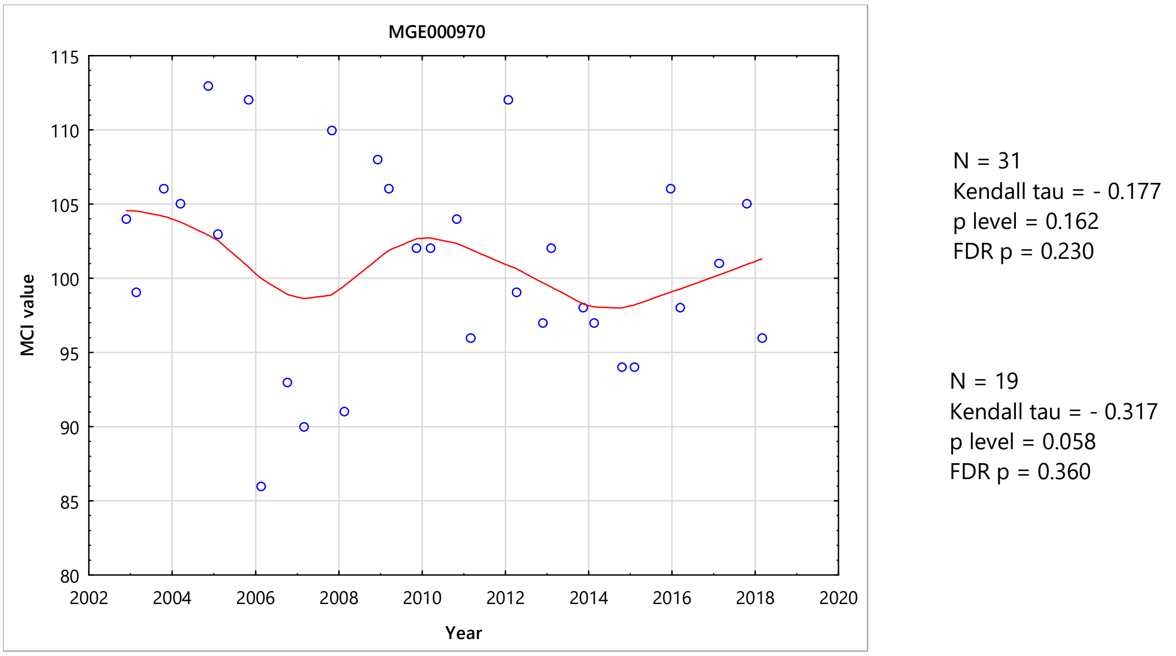


Figure 59 LOWESS trend plot of MCI data at the SH3 site, Mangorei Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

The slightly negative decline over the 16-year period has not been a statistically significant at this site. The trendline range of scores (7 units) has been indicative of marginal ecological importance in variability. During the period, the trendline has alternated between 'fair' and 'good' generic stream health.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, congruent with the full dataset. The trendline for the most recent ten-year period has alternated between 'fair' and 'good' generic stream health.

3.2.3 Patea River

The Patea River is a large, ringplain river that originates within Egmont National Park and flows in a southeasterly direction. Three SEM sites are located in the upper and middle reaches of the river. The results of spring and summer (2017-2018) surveys are presented in Table 94 and Table 95, Appendix I.

3.2.3.1 Barclay Road site (PAT000200)

3.2.3.1.1 Taxa richness and MCI

Forty-four surveys have been undertaken at this upper reach, shaded site adjacent to the National Park boundary in the Patea River between October 1995 and March 2017. These results are summarised in Table 34, together with the results from the current period, and illustrated in Figure 60.

Table 34 Results of previous surveys performed in the Patea River at Barclay Road, together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		April 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000200	44	23-35	30	127-150	138	27	139	25	140

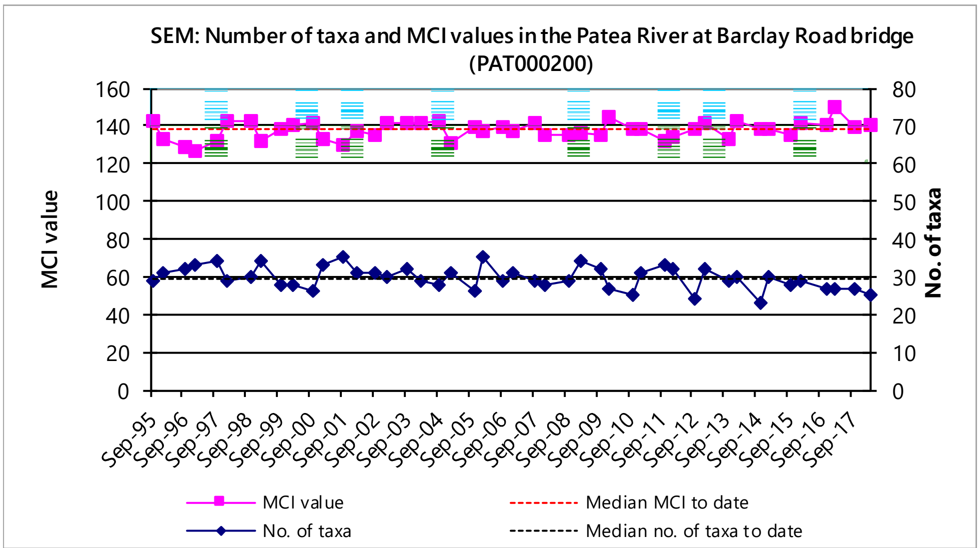


Figure 60 Numbers of taxa and MCI values in the Patea River at Barclay Road

A moderate range of richness (23 to 35 taxa) has been found with a relatively high median richness of 30 taxa, typical of richness in ringplain streams and rivers near the National Park boundary. During the 2017-2018 period spring (27 taxa) and summer (25 taxa) richness were slightly lower than the historical median.

MCI values have had a moderate range (23 units) at this site, typical of a National Park boundary site. The high median value (138 units) has been typical of upper reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (139 units) and summer 2018 (140 units) scores categorised this site as having 'very good' (spring) and 'excellent' (summer) health generically. (Table 3). The historical median score (138 units) placed this site in the 'very good' category for generic health.

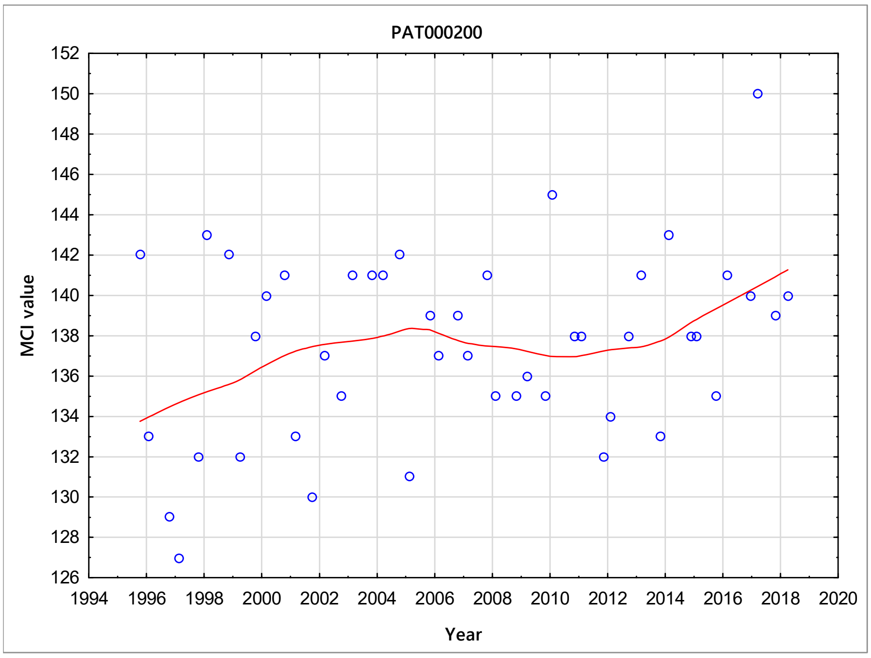
3.2.3.1.2 Predicted stream 'health'

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

The REC predicted MCI value (Leathwick, et al. 2009) was 129 units. The historical median, spring and summer scores were not significantly different to this value.

3.2.3.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 90). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Patea River at Barclay Road.



N = 46
Kendall tau = +0.144
p value = 0.159
FDR p = 0.230

N = 20
Kendall tau = +0.313
p value = 0.054
FDR p = 0.36

Figure 61 LOWESS trend plot of MCI data at the Barclay Road site, Patea River for the full dataset with Mann-Kendall test for the full and ten-year dataset

No statistically significant temporal trend in MCI scores has been found at this upper catchment site over the twenty-three year monitoring period during which there has been a minimal overall trend of slight improvement. The trendline range (7 units) did show minor ecological importance. The trendline has indicated 'very good' generic river health untill 2017 when when it improved to 'excellent' (Table 3) at this relatively pristine site just outside the National Park boundary.

The ten-year trend showed a non-significant improving trend that is of minor ecological importance. This was consistent with the trend for the full period.

3.2.3.2 Swansea Road site (PAT000315)

3.2.3.2.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Patea River at this mid-reach site at Swansea Road, Stratford between October 1995 and March 2017. These results are summarised in Table 35, together with the results from the current period, and illustrated in Figure 62.

Table 35 Results of previous surveys performed in the Patea River at Swansea Road, together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Apr 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000315	44	20-32	26	99-130	111	21	129	24	113

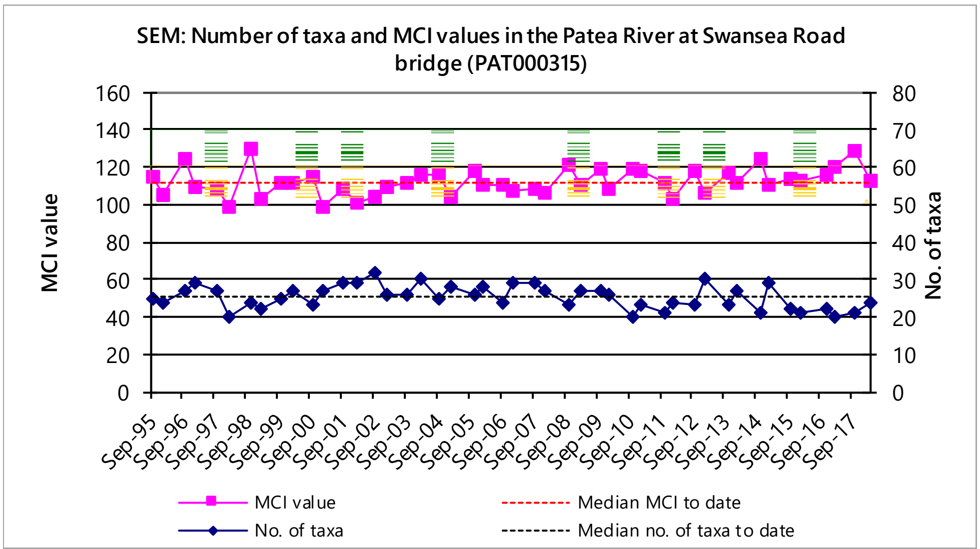


Figure 62 Numbers of taxa and MCI values in the Patea River at Swansea Road

A moderate range of richness (20 to 32 taxa) has been found, with a median richness of 26 taxa, typical of richness in the mid reaches of ringplain streams and rivers. During the 2017-2018 period, spring (21 taxa) and summer (24 taxa) richness were slightly lower than the median taxa number.

MCI values have had a relatively wide range (31 units) at this site, more so than typical of many sites in the mid reaches of ringplain rivers. The median value (111 units) has been relatively typical of scores in mid-reach sites elsewhere on the ringplain. The spring 2017 (129 units) score was significantly higher than the historical median, while the summer 2018 (113 units) score was not significantly different to the historical median. These scores categorised this site as having 'very good' (spring) and 'good' (summer) health generically (Table 3). The historical median score (111 units) placed this site in the 'good' category for generic health.

3.2.3.2.2 Predicted stream 'health'

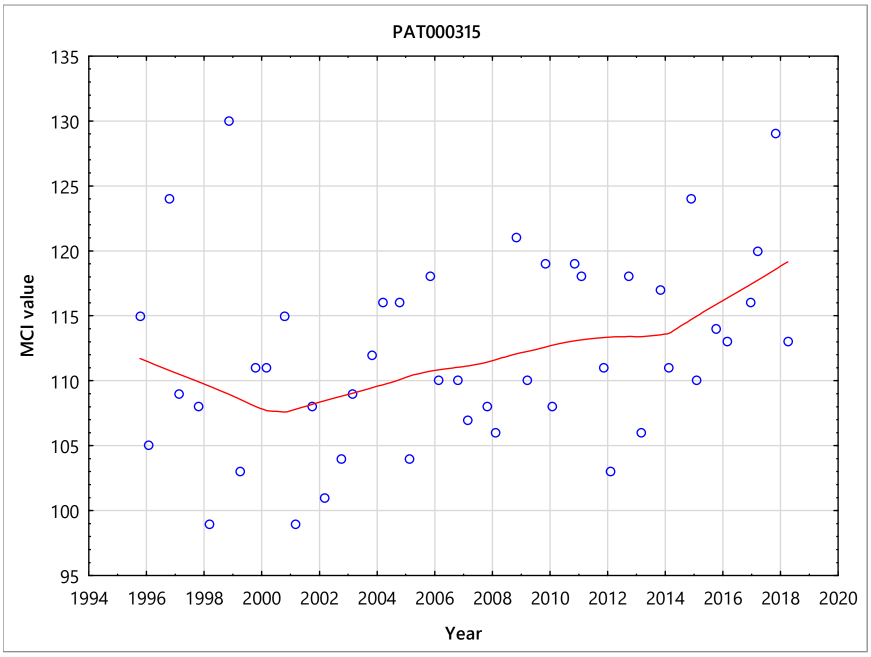
The Patea River site at Swansea Road, Stratford is 12.4 km downstream of the National Park boundary at an altitude of 300 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 103 units for this site. The historical site median and summer scores were not significantly higher than the distance predictive value. The spring 2017 survey (129 units) score was significantly higher than the distance predictive value (Stark, 1998).

The REC predicted MCI value (Leathwick, et al. 2009) was 112 units. The summer and historical median scores were not significantly different to this value, while the spring value was significantly higher.

3.2.3.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 63). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on

23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Patea River at Swansea Road.



N = 46
Kendall tau = +0.242
p value = 0.018
FDR p = 0.040

N = 20
Kendall tau = +0.069
p value = 0.669
FDR p = 0.79

Figure 63 LOWESS trend plot of MCI data at the Swansea Road site, Patea River for the full datset with Mann-Kendall test for the full and ten-year dataset

The small positive temporal trend in MCI scores was statistically significant over the 23-year period after FDR was applied to the p value. The trendline range of scores (11 units) was of no ecological importance. The trendline range of scores consistently indicated 'good' generic river health (Table 3) throughout the monitoring period.

In contrast to the full dataset, the ten-year period had no statistical significanct trend.

3.2.3.3 Skinner Road site (PAT000360)

3.2.3.3.1 Taxa richness and MCI

Forty-four 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 March 2017. These results are summarised in Table 36, together with the results from the current period, and illustrated in Figure 64.

Table 36 Results of previous surveys performed in the Patea River at Skinner Road, together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Apr 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000360	44	15-33	23	86-105	98	18	112	24	99

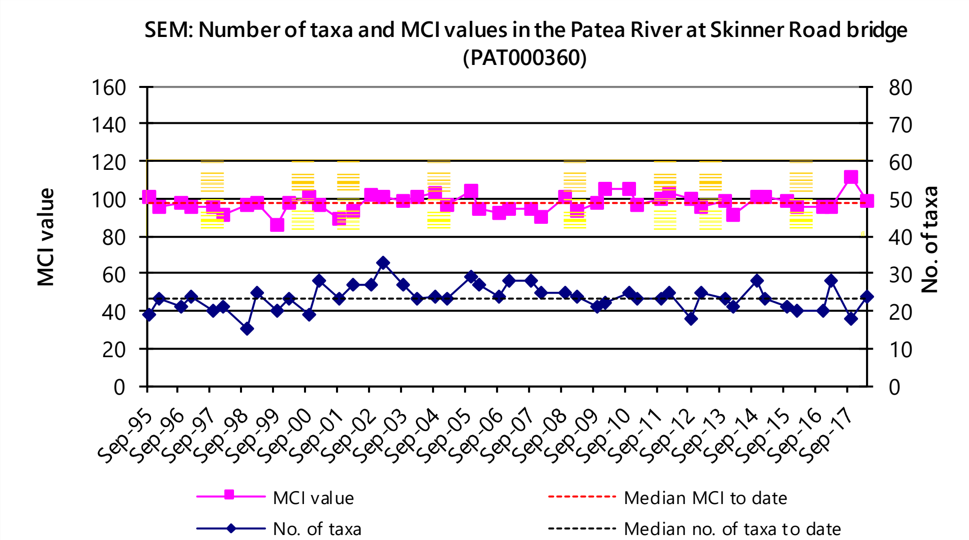


Figure 64 Numbers of taxa and MCI values in the Patea River at Skinner Road

A wide range of richness (15 to 33 taxa) has been found with a median richness of 23 taxa (more representative of typical richness in the mid-reaches of ringplain streams and rivers). During the 2017-2018 period spring (18 taxa) and summer (24 taxa) richness were within five taxa of the historical median.

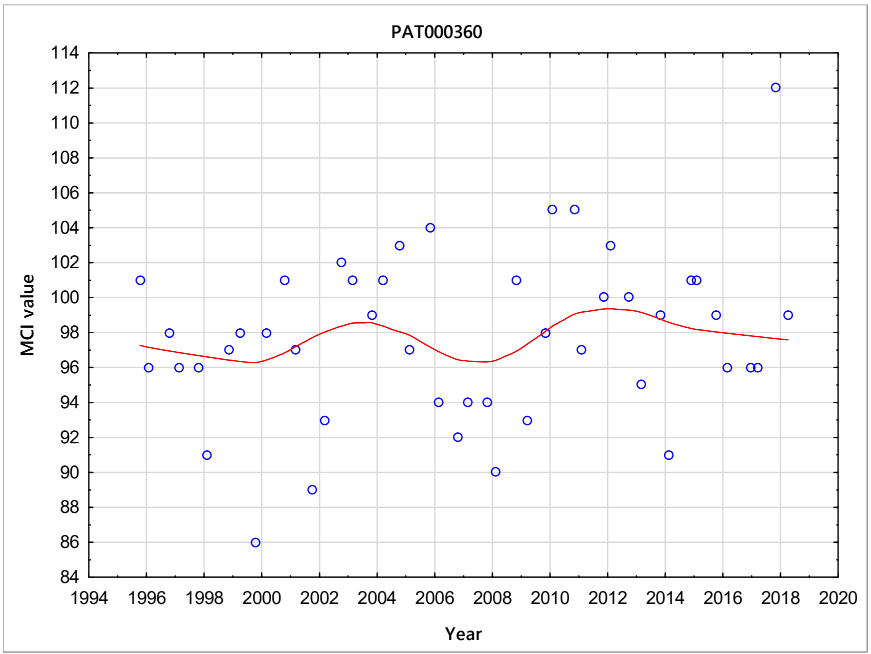
MCI values have had a moderate range (19 units) at this site, typical of sites in the mid-reaches of ringplain streams and rivers. The median value (98 units) has been relatively typical of the scores at mid-reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (112 units) was significantly higher than the historical median and was the highest score recorded at this site ot date by seven units. The summer 2018 (99 units) score was not significantly different to the historical median. They categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (98 units) placed this site in the 'fair' category for generic health.

3.2.3.3.2 Predicted stream 'health'

The Patea River site at Skinner Road is 19.2 km downstream of the National Park boundary at an altitude of 240 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 99 for this site. The historical site median (98) was only one unit lower than the distance predictive value. The spring 2017 score was significantly higher than this value and the summer 2018 score was not significantly different to the predicted distance value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 109 units. The historical, spring and summer scores were also not significantly different to this value.

3.2.3.3.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 65). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Patea River at Skinner Road.



N = 46
Kendall tau = +0.129
p value = 0.208
FDR p = 0.280

N = 20
Kendall tau = -0.103
p value = 0.525
FDR p = 0.700

Figure 65 LOWESS trend plot of MCI data at the Skinner Road site, Patea River for the full satset with Mann-Kendall test for the full and ten-year dataset

The small positive temporal trend in MCI scores over the 23-year period has not been statistically significant. An apparent decline in scores between 2004 and 2008 has been followed by some improvement followed by a more recent plateau in scores. The very small range exhibited by the trendline (three units) has been of no ecological importance over the period. The trendline consistently indicated 'fair' generic river health (Table 3).

In contrast to the full dataset, the ten-year trend shows a slight declining trend. However, this was neither ecologically or statisitcally significant.

3.2.3.4 Discussion

The Patea River at the SEM sites was found to have moderate to moderately high taxa richness which was consistent with the results from past surveys. As was typical for the river taxa richness decreased slightly in a downstream direction.

The upper site had 'very good' and 'excellent' macroinvertebrate community health in spring and summer respectively, despite these scores only differing by one unit. The middle site had generally 'good' health with 'very good' and 'good' health observed in spring and summer respectively. The lower site was in the poorest condition despite recording its highest MCI score to date in spring 2017.

Overall, MCI scores fell in a downstream direction between the upper site and the furthest downstream site by 27 units in spring and 41 units in summer, over a river distance of 17.3 km indicating a significant deterioration in macroinvertebrate community health between the upper and lower site. This was consistent with previous surveys with a median decrease of 42 units recorded over all 44 surveys.

The time trend analysis showed a significant improvement at the middle site for the full period only, while no significant trends were recorded for the any other site, indicating that macroinvertebrate community health had not been significantly improving or deteriorating at these sites.

3.2.4 Punehu Stream

The Punehu Stream is a ringplain stream whose source is located within Egmont National Park and flows from north to south with its mouth located east of the town of Opunake. There are two SEM sites, one located in its upper middle reaches and the other located in its lower reaches. The results of the spring and summer (2017-2018) surveys are summarised in Table 96 and Table 97, Appendix I.

3.2.4.1 Wiremu Road site (PNH000200)

3.2.4.1.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Punehu Stream between October 1995 and March 2017 at this open, upper mid-reach site in farmland, 4 km downstream of the National Park These results are summarised in Table 37 together with the results from the current period, and illustrated in Figure 66.

Table 37 Results of previous surveys performed in the Punehu Stream at Wiremu Road together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000200	44	19-31	27	104-137	124	25	130	32	124

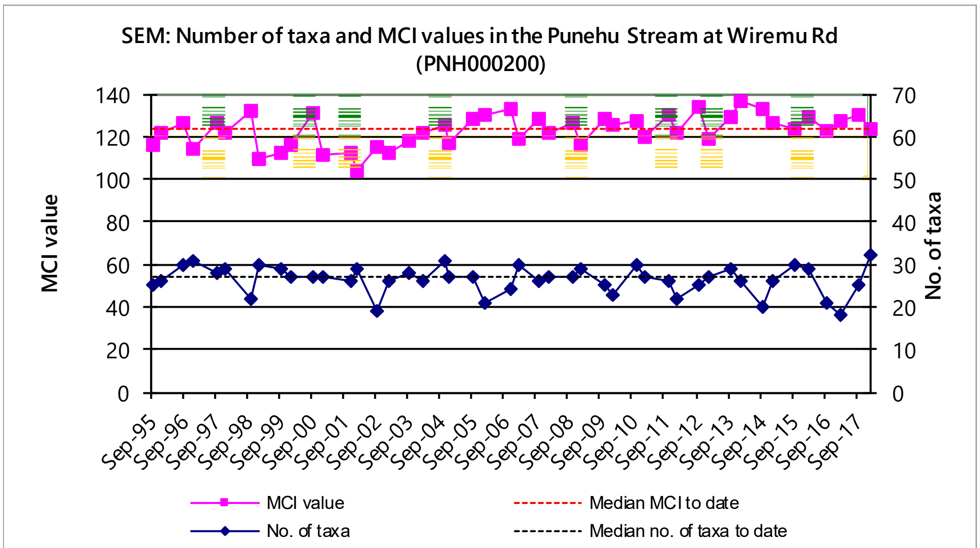


Figure 66 Numbers of taxa and MCI values in the Punehu Stream at Wiremu Road

A moderate range of richness (19 to 31 taxa) has been found with a median richness of 27 taxa (more representative of typical richness in the mid reaches of ringplain streams and rivers (TRC, 2017b)). During the 2017-2018 period, spring richness (25 taxa) and summer (32 taxa) richness were moderately high and similar to the median richness. The summer taxa ruichness was the highest recorded at this site to date.

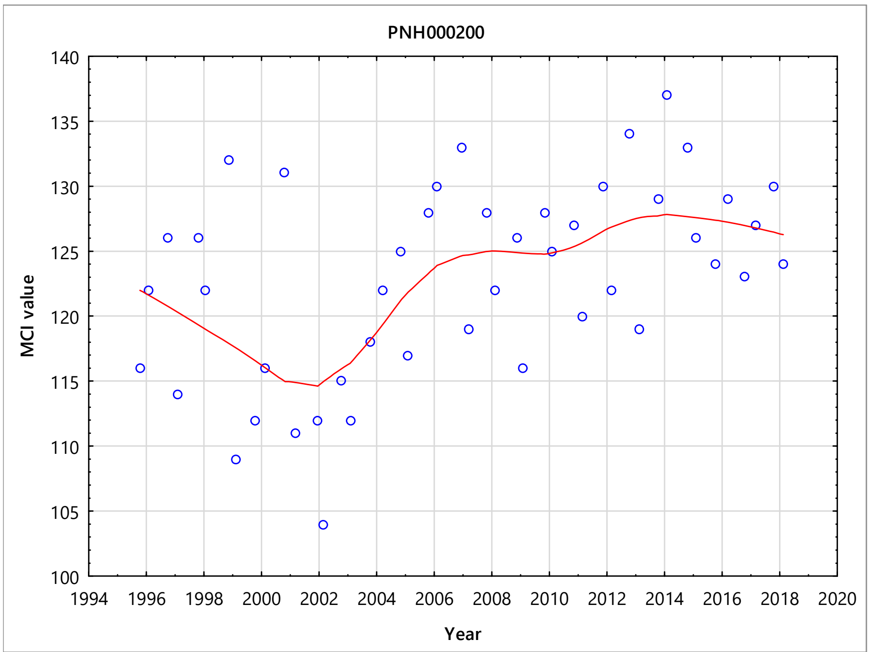
MCI values have had a moderate range (33 units) at this site, typical of a site in the (upper) mid reaches of a ringplain stream in more open farmland. The median value (124 units) has been typical of mid reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (130 units) and summer 2018 (124 units) scores were not significantly different to the historical median (Stark, 1998). These scores categorised this site as having 'very good' generic health (Table 3) in spring and summer. The historical median score (123 units) placed this site in the 'very good' category for the generic health.

3.2.4.1.2 Predicted stream 'health'

The Punehu Stream site at Wiremu Road is 4.4 km downstream of the National Park boundary at an altitude of 270 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 115 for this site. The historical site median (124 units) was a non-significant nine units above the distance predictive value. The spring 2017 survey (130 units) score was significantly higher than this value, while the summer 2018 survey (124 units) score was not significantly different from the distance predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 121 units. The historical site median, spring and summer scores were not significantly different from this value.

3.2.4.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 67). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Punehu Stream at Wiremu Road.



N = 46
Kendall tau = +0.325
p level = 0.001
FDR p < 0.001

N = 20
Kendall tau = +0.123
p level = 0.450
FDR p = 0.69

Figure 67 LOWESS trend plot of MCI data at the Wiremu Road site, Punehu Stream

A steady increase in MCI scores had been apparent between 2002 and 2007, and again since 2010, resulting in the positive trend in scores over the entire period which has been statistically significant (FDR p < 0.01 level). The trendline range (13 units) has been of ecological importance, particularly since 2002 (coincident with localised riparian fencing and planting of the true left-bank of the stream). Overall, the trendline range was indicative of 'very good' generic stream health (Table 3) apart from a short period of 'good' health from 1997 to 2005.

The ten-year trend showed a slight positive trend, however unlike the trend for the full dataset this was of no statistical or ecological significance.

3.2.4.2 SH 45 site (PNH000900)

3.2.4.2.1 Taxa richness and MCI

Forty-four surveys have been undertaken at this lower reach site at SH 45 in the Punehu Stream between October 1995 and March 2017. These results are summarised in Table 38, together with the results from the current period, and illustrated in Figure 68.

Table 38 Results of previous surveys performed in the Punehu Stream at SH 45 together with 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000900	44	10-26	21	70-114	89	20	109	21	90

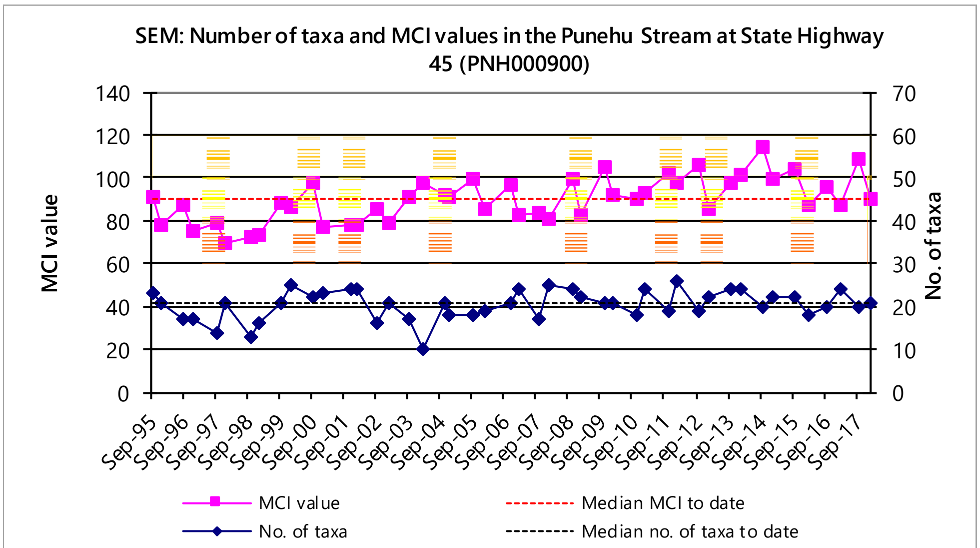


Figure 68 Numbers of taxa and MCI values in the Punehu Stream at SH 45

A wide of richness (10 to 26 taxa) has been found with a median richness of 21 taxa, relatively typical of richness in the lower reaches of ringplain streams and rivers. During the 2017-2018 period, spring (20 taxa) and summer (21 taxa) richness were moderate and similar to the historical median.

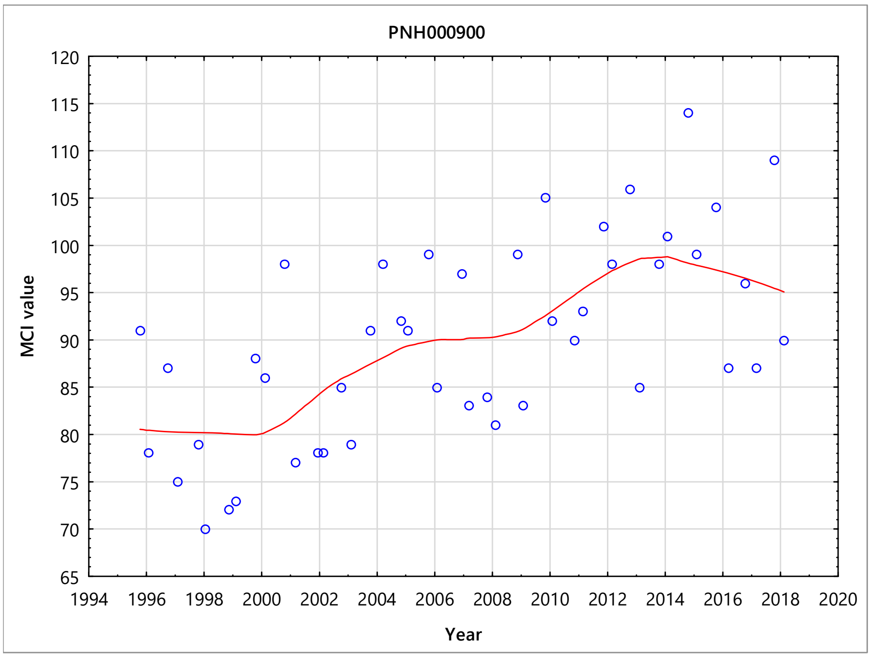
MCI scores have had a relatively wide range (44 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (89 units) also has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (109 units) score was significantly higher than the historical median, while the summer 2018 (90 units) score was not significantly different to the historical median (Stark, 1998). These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (89 units) placed this site in the 'fair' category for generic health.

3.2.4.2.2 Predicted stream 'health'

The Punehu Stream site at SH 45 is 20.9 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 98 for this site. The historical site median (89 units) was a non-significant (Stark, 1998) nine units lower than the distance predictive value. The spring 2017 survey (109 units) score was significantly higher than this value, while the summer 2018 (90 units) score was not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 100 units. The historical site median score was significantly lower than this value but there was no significant difference for the spring and summer survey scores.

3.2.4.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 102). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Punehu Stream at SH 45.



N = 46
Kendall tau = +0.448
p level < 0.001
FDR p < 0.001

N =20
Kendall tau = +0.064
p level = 0.694
FDR p = 0.81

Figure 69 LOWESS trend plot of MCI data at the SH 45 site, Punehu Stream for the full datset with Mann-Kendall test for the full and ten-year dataset

This site's MCI scores have shown a strong positive temporal trend over the 23-year period which was statistically significant ($p < 0.01$) after FDR application. The trendline range of scores (18 units) has been ecologically important over this period with scores mainly indicative of 'poor' generic stream health (Table 3) prior to early 1999 improving to 'fair' health throughout most of the subsequent period and to 'good' health more recently.

In contrast to the full dataset the ten-year trend showed no trend of any ecological or statistical significance.

3.2.4.3 Discussion

The Punehu Stream at the SEM sites was found to have moderate taxa richness which was consistent with the results from past surveys. The upper mid-reach (Wiremu Road) site had 'very good' macroinvertebrate community health while the lower reach (SH 45) site had 'good' to 'fair' macroinvertebrate community health.

MCI scores typically significantly fell in a downstream direction in both spring (by 21 units) and in summer (by 34 units), over a stream distance of 16.5 km through the (upper) mid to lower reaches of this stream. Issues have occurred on occasions with consented dairy shed discharge compliance and cumulative impacts of such discharges in the Mangatawa Stream sub-catchment in the local vicinity of the lower site (TRC, 2011 and Fowles, 2014). Changes in macroinvertebrate community structure at the lower site, especially when compared with the upper mid-reach site, reflect ongoing issues with nutrient enrichment.

The time trend analysis showed significant positive trends for both sites for the full dataset indicating that over time macroinvertebrate community health has been significantly improving at both sites. The ten-year trend for both sites was positive but non-significant suggesting that macroinvertebrate health was not significantly improving over the more recent time period or not at a level that was great enough to be statistically significant.

3.2.5 Tangahoe River

The Tangahoe River is an eastern hill country river flowing north to south with a river mouth located east of Hawera. Three sites were included in the SEM programme in 2007 for the purpose of monitoring long-term land use changes (afforestation) particularly in the upper-mid catchment. The Fonterra, Hawera dairy factory abstracts water from the river in the lower catchment for processing purposes. Two of the three sites are in the upper to mid, shallow gradient, reaches of the river (the upstream site within 4 km of the headwaters) with the third site in the lower reaches, some 4 km from the coast.

The results of the 2017-2018 spring and summer surveys are presented in Table 98 and Table 99, Appendix I.

3.2.5.1 Upper Tangahoe Valley Road site (TNH000090)

3.2.5.1.1 Taxa richness and MCI

Twenty surveys have been undertaken at this upper reach site in the Tangahoe River between December 2007 and March 2017. These results are summarised in Table 39, together with the results from the current period, and illustrated in Figure 70.

Table 39 Results of previous surveys performed in the Tangahoe River at upper Tangahoe Valley Road, together with 2017-2018 results

Site code	SEM data (2007 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000090	20	14-31	24	90-107	100	14	107	18	97

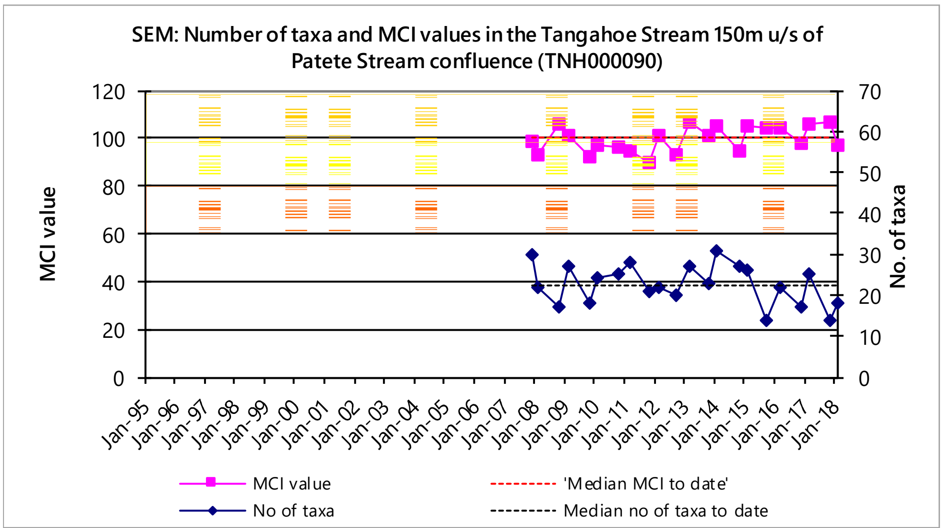


Figure 70 Numbers of taxa and MCI values in the Tangahoe River at Upper Tangahoe Valley Road

A relatively wide range of richness (14 to 31 taxa) has been found with a moderate median richness of 24 taxa (lower than richness 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, 2017b). During the 2017-2018 period, spring (14 taxa) and summer (18 taxa) taxa richness was lower than the historical median.

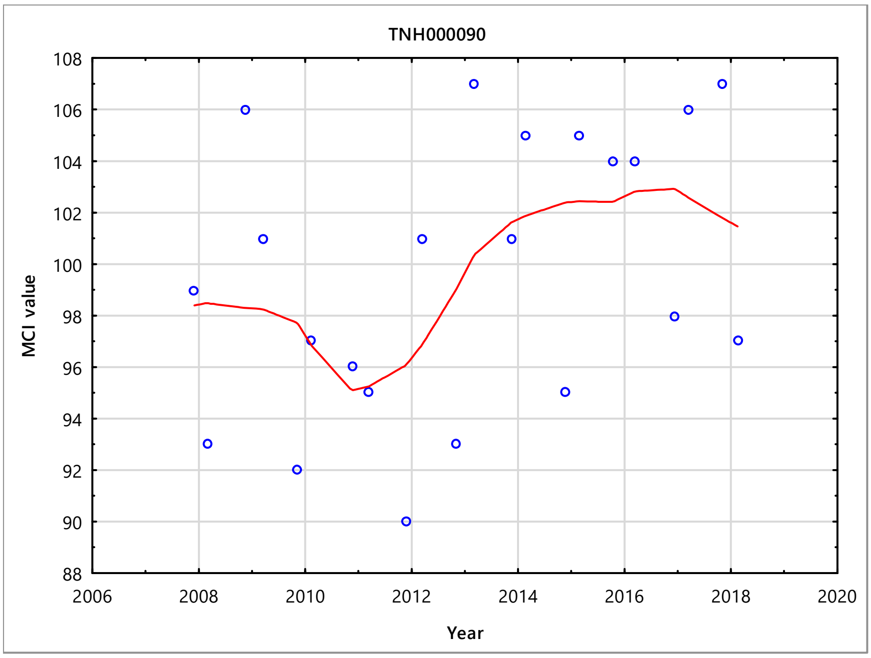
MCI values have had a relatively narrow range (17 units) at this site, typical of scores at sites toward the upper reaches of streams and rivers. The spring 2017 (107 units) and summer 2018 (97 units) scores were not significantly different to the historical median score, although the spring MCI score was equal to the highest recorded at this site to date. These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (100 units) placed this site in the 'good' category for the generic method of assessment.

3.2.5.1.2 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 REC predicted MCI value (Leathwick, et al. 2009) was 110 units and therefore the historical median and spring scores were not significantly different but the summer score was significantly lower.

3.2.5.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 71). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the full SEM results (2007-2018) and the most recent ten-years of results (2008-2018) from the site in the Tangahoe River at upper Tangahoe Valley Road.



N = 22
Kendall tau = 0.261
p level = 0.089
FDR p = 0.140

N = 20
Kendall tau = 0.232
p level = 0.153
FDR p = 0.460

Figure 71 LOWESS trend plot of MCI data in the Tangahoe River for the upper Tangahoe Valley site for the full dataset with Mann-Kendall test for full and ten-year dataset

There was a small, positive, but non-significant trend for this hill country catchment site toward the upper reaches. The trendline range (eight units) was of limited ecological importance to date. The trendline range indicated 'fair' health from 2007-2013 before improving to 'good' health for the last five years.

There was a non-significant positve trend in MCI scores over the most recent ten-year period, congruent with the only slightly larger full dataset. The trendline range indicated 'fair' health from 2008-2013 before improving to 'good' health for the last five years

3.2.5.2 Tangahoe Valley Road bridge site (TNH000200)

3.2.5.2.1 Taxa richness and MCI

Twenty surveys have been undertaken at this mid reach site in the Tangahoe River between December 2007 and March 2017. These results are summarised in Table 40, together with the results from the current period, and illustrated in Figure 72.

Table 40 Results of previous surveys performed in the Tangahoe River at Tangahoe Valley Road bridge, together with 2017-2018 results

Site code	SEM data (2007 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000200	20	17-35	25	92-110	103	17	111	25	102

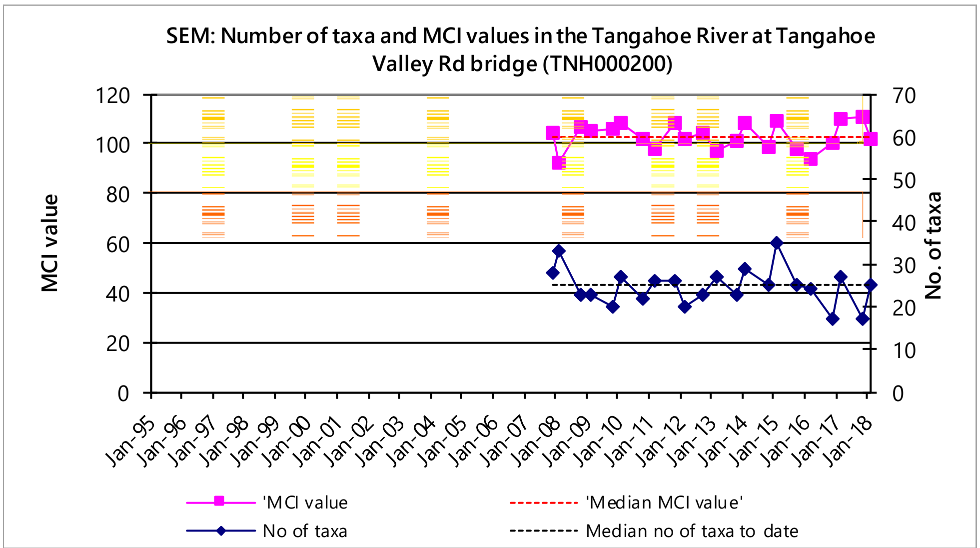


Figure 72 Numbers of taxa and MCI values in the Tangahoe River at Tangahoe Valley Road bridge

A moderate range of richness (17 to 33 taxa) has been found with a relatively good median richness of 25 taxa (typical of richness in the mid-reaches of hill country rivers). During the 2017-2018 period, spring richness (17 taxa) was significantly lower than the historical median (25 taxa) and equal to the lowest taxa richness recorded at the site to date, while summer richness (25 taxa) was equal to the historical median.

MCI values have had a moderate range (18 units) at this site, typical of a site in the mid-reaches of hill country streams and rivers. The spring 2017 (111 units) and summer 2018 (102 units) scores were not significantly different to the historical median (103 units), althought the spring score was the highest recorded at this site to date. These scores categorised this site as having 'good' (spring and summer) health generically (Table 3). The historical median score (103 units) placed this site in the 'good' category for the generic assessment of health.

3.2.5.2.2 Predicted stream 'health'

The Tangahoe River site at Tangahoe Valley Road Bridge, at an altitude of 65 m asl, is in the mid reaches of a river draining a hill country catchment. The REC predicted MCI value (Leathwick, et al. 2009) was 108 units. The historical, spring and summer scores were not significantly different to this predictive value either (Stark, 1998).

3.2.5.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 73). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the full SEM results (2007-2018) and the most recent ten-years of results (2008-2018) from the site in the Tangahoe River at the Tangahoe Valley Road bridge.

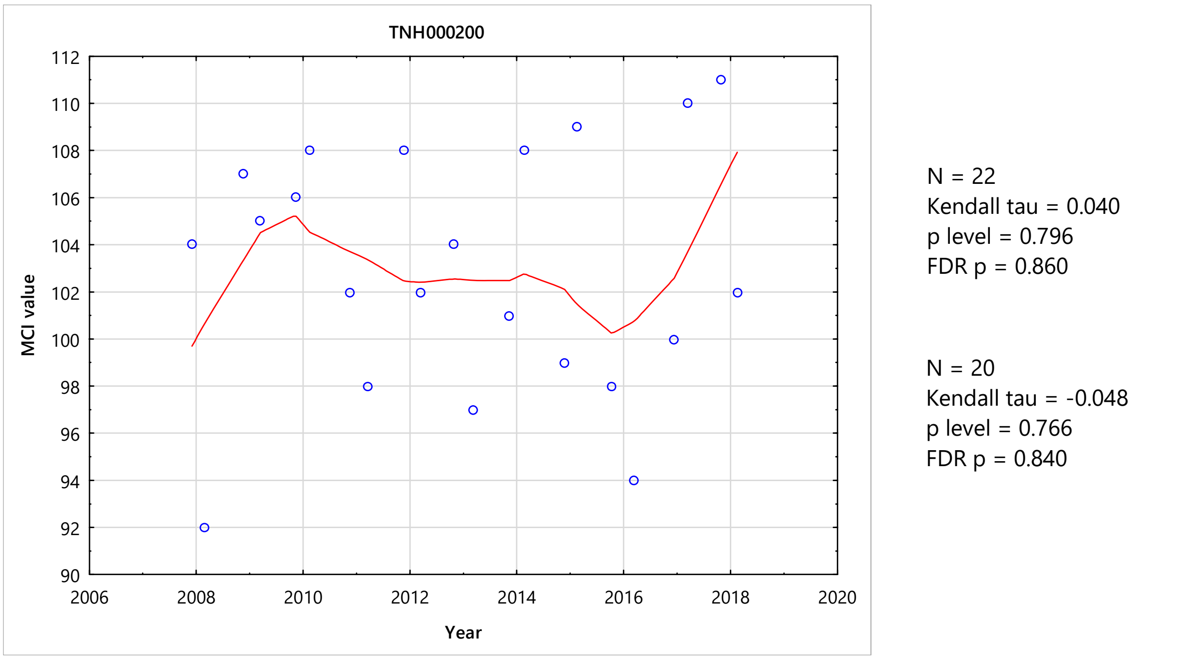


Figure 73 LOWESS trend plot of MCI data in the Tangahoe River for the Tangahoe Valley Road bridge site for the full datset with Mann-Kendall test for the full and ten-year dataset

There was a very small, postive, non-significant trend for this mid river reach, hill country catchment site. The trendline range (eight units) over the period has been of limited ecological importance. The trendline range has indicated 'good' generic river health.

There was a very small, negative, non-significant trend in MCI scores over the most recent ten-year period, surprisingly in constrast to the largely similar full dataset. The trendline for the most recent ten-year period was indicative of 'good' health with a sharp improvement in the trend since 2016.

3.2.5.3 Site downstream of railbridge (TNH000515)

3.2.5.3.1 Taxa richness and MCI

Twenty surveys have been undertaken at this lower reach site in the Tangahoe River between December 2007 and March. These results are summarised in Table 41, together with the results from the current period, and illustrated in Figure 74.

Table 41 Results of previous surveys performed in the Tangahoe River d/s of railbridge, together with 2017-2018 results

Site code	SEM data (2007 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000515	20	13-26	20	78-104	94	21	94	17	86

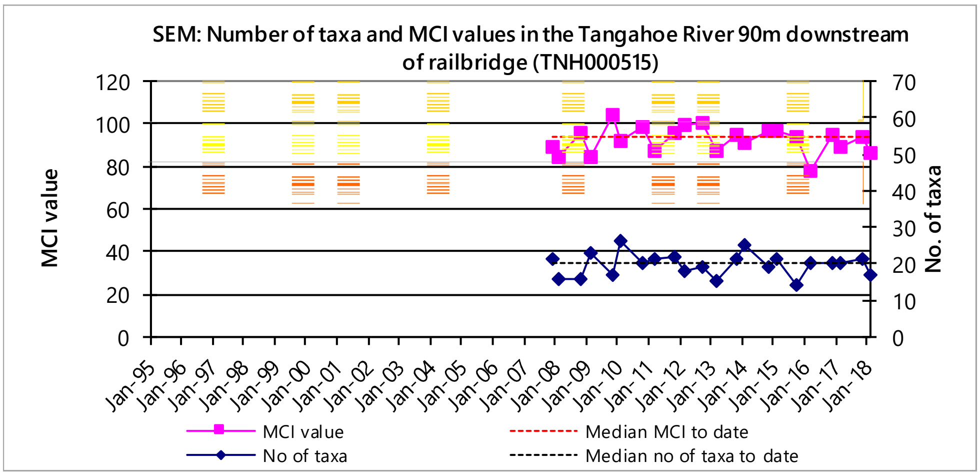


Figure 74 Numbers of taxa and MCI values in the Tangahoe River downstream of the railbridge

A moderate range of richness (13 to 26 taxa) have been found with a slightly higher than typical median richness of 20 taxa for a site in the lower reaches of a hill country river (TRC, 2017b). During the 2017-2018 period, spring (21 taxa) and summer (17 taxa) richness were similar to the median richness.

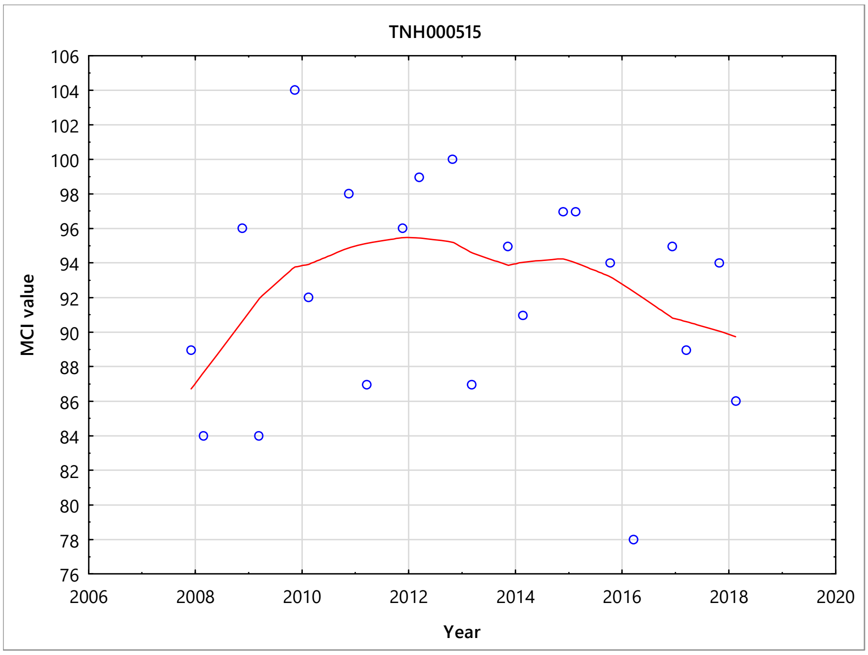
MCI values also have had a moderate range (26 units) at this site, narrower than typical of sites in the lower reaches of hill country streams and rivers. The spring 2017 (94 units) and summer 2018 (86 units) scores were very similar to the historical median. These scores categorised this site as having 'fair' health generically (Table 3). The historical median score (94 units) placed this site in the 'fair' category for the generic method of assessment.

3.2.5.3.2 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 REC predicted MCI value (Leathwick, et al. 2009) was 95 units and therefore the historical, spring and summer scores were not significantly different (Stark, 1998).

3.2.5.3.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 75). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the full SEM results (2007-2018) and the most recent ten-years of results (2008-2018) from the site in the Tangahoe River downstream of the railbridge.



N = 22
Kendall tau = -0.070
p level = 0.647
FDR p = 0.770

N = 20
Kendall tau = -0.219
p level = 0.178
FDR p = 0.460

Figure 75 LOWESS trend plot of MCI data for the Tangahoe River site downstream of the railbridge for the full dataset with Mann-Kendall test for the full and ten-year dataset

There was a non-significant negative trend for this lower river reach, hill country catchment site. The trendline range (8 units) has bordered on ecologically important but overall there has been no real change over the monitored period. The trendline range have indicated 'fair' generic river health over the period to date.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, congruent with the full dataset, with a decline in the trendline from 2012 onwards. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.5.4 Discussion

The Tangahoe River at the SEM sites was found to have moderate to moderately low taxa richness. The upper site had slightly lower than usual taxa richness for both spring and summer, coincident with a logging operation which may have reduced taxa richness. The middle site also had slightly lower taxa richness for the spring survey, but not summer, and the lower site had typical taxa richness.

The upper reach (upper Tangahoe Valley Road) site had 'good' macroinvertebrate community health during spring, with the score being the equal highest recorded to date, possibly due to the logging operation causing more leaf packs and deposited wood to be present on the substrate which favours pollution sensitive taxa. The MCI score for the summer survey indicated 'fair' health and was more typical for the site. The middle site at the Tangahoe Valley Road Bridge had 'good' macroinvertebrate community health for both spring and summer but the spring result was the highest recorded result to date, again, possibly due to the effects of the logging operation. The lower reach site at the railbridge had 'fair' macroinvertebrate community health which was typical for the site.

MCI scores fell in a downstream direction in both spring (by 13 units) and in summer (by 11 units), over a distance of 30.2 km (and decrease in elevation of 70 m) though MCI scores actually improved from the upper to middle site. The improvement in macroinvertebrate health would be related to better quality habitat present at the middle site which has a riffle with a cobbles/ boulder substrate as opposed to the upper site with a clay dirt substrate. Using the long-term median SEM MCI scores for each site (Appendix II), there is normally an improvement in MCI scores between the upper reach (Upper Tangahoe Valley Road) and the mid-reach (Tangahoe Valley Road bridge) sites by six units. The decline between the mid-reach site and lower reach (railbridge) site has historicalally been nine units.

The time trend analyses showed no significant trends for any site indicating that macroinvertebrate health was not significantly improving or deteriorating though a relatively small time range of eleven years may be contributing to the lack of significance.

3.2.6 Timaru Stream

Timaru Stream is a ringplain stream arising within Egmont National Park and flows from east to west. There are two SEM sites situated on the stream. In the 2008-2009 period severe headwater erosion events had impacted upon the macroinvertebrate communities of the upper reaches of this stream in particular (TRC, 2009). The results for the spring and summer (2017-2018) surveys are presented in Table 100 and Table 101, Appendix I.

3.2.6.1 Carrington Road site (TMR000150)

3.2.6.1.1 Taxa richness and MCI

Forty-three 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 2017. These results are summarised in Table 42, together with the result from the current period, and illustrated in Figure 76.

Table 42 Results of previous surveys performed in the Timaru Stream at Carrington Road, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TMR000150	43	8-33	25	119-152	138	28	140	34	136

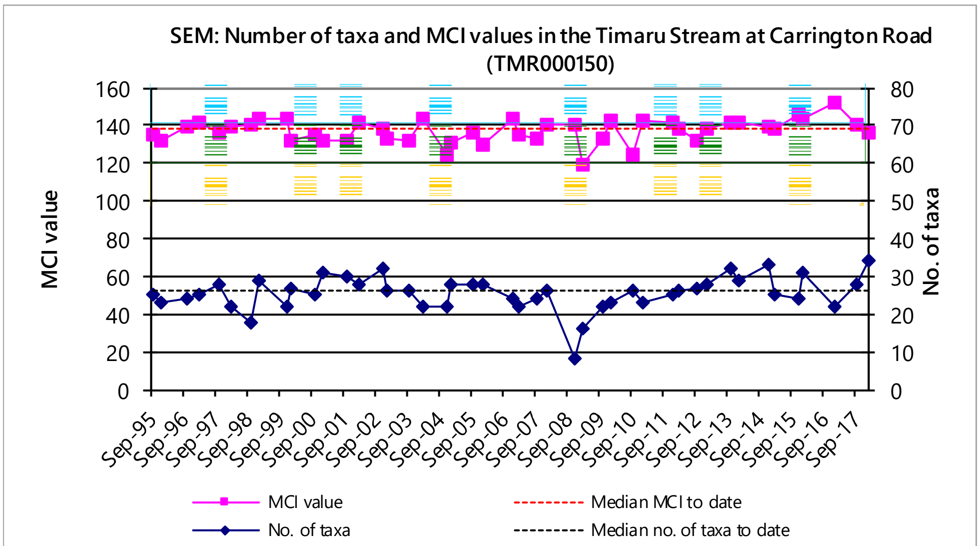


Figure 76 Numbers of taxa and MCI values in the Timaru Stream at Carrington Road

Taxa richness was typically moderately high for the site (median richness of 25 taxa) with only one low result in December 2008 (eight taxa) due to headwater erosion effects over the 2008-2009 period which markedly reduced richness. The median richness was similar to the typical richness (28 taxa) in ringplain streams and rivers near the National Park boundary over 400 m in altitude (TRC, 2017b). During the 2017-2018 period, spring (28 taxa) richness was slightly higher than the median, while the summer (34 taxa) richness was substantially higher than median and was the highest recorded at this site to date by one taxon.

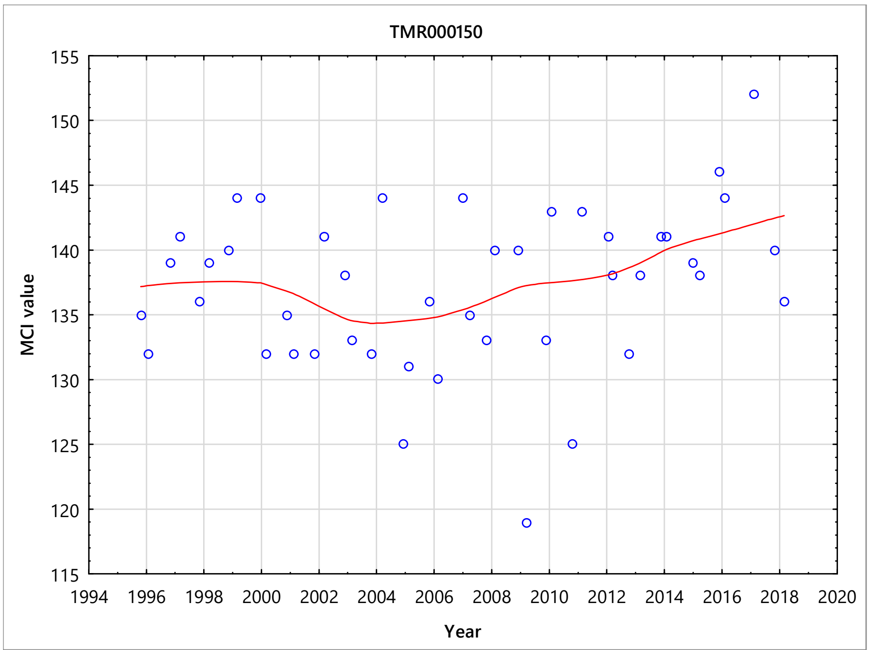
MCI values have had a wider range (33 units) at this site than typical of a site near the National Park boundary due to the low value (119 units) after the 2008-2009 headwater erosion period. However, the median value (138 units) is slightly higher than typical upper reach sites elsewhere on the ringplain (134 units). The spring 2017 (140 units) and summer 2018 (136 units) scores were similar to the historical median. The scores categorised this site as having 'excellent' (spring) and 'very good' (summer) health generically (Table 3). The historical median score (138 units) placed this site in the 'very good' category for the generic health.

3.2.6.1.2 Predicted stream 'health'

The Timaru Stream at Carrington Road is within the National Park boundary at an altitude of 420 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median (138 units) and spring and summer scores were not significantly different to the predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 141 units. The historical site median, spring and summer scores were not significantly different to this value.

3.2.6.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 77). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Timaru Stream at Carrington Road.



N = 45
Kendall tau = +0.145
p level = 0.160
FDR p = 0.230

N = 19
Kendall tau = +0.246
p level = 0.142
FDR p = 0.46

Figure 77 LOWESS trend plot of MCI data at the Carrington Road site for the full dataset with Mann-Kendall test for the full and ten-year dataset

There was a small, positive, non-significant trendover the full data set. The trendline had a range over nine units which was not ecologically important. The trendline scores have been indicative of 'very good' generic stream health from 1995 to 2014, increasing to 'excellent' health since 2014 (Table 3).

The ten-year period also showed a small positive trend of neither ecological or statistical significance.

3.2.6.2 SH45 site (TMR000375)

3.2.6.2.1 Taxa richness and MCI

Forty-three surveys have been undertaken in the Timaru Stream at this lower, mid-reach site at SH45 between October 1995 and February 2017. These results are summarised in Table 43, together with the results from the current period, and illustrated in Figure 78.

Table 43 Results of previous surveys performed in the Timaru Stream at SH45, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TMR000375	43	13-35	26	89-120	103	31	108	28	101

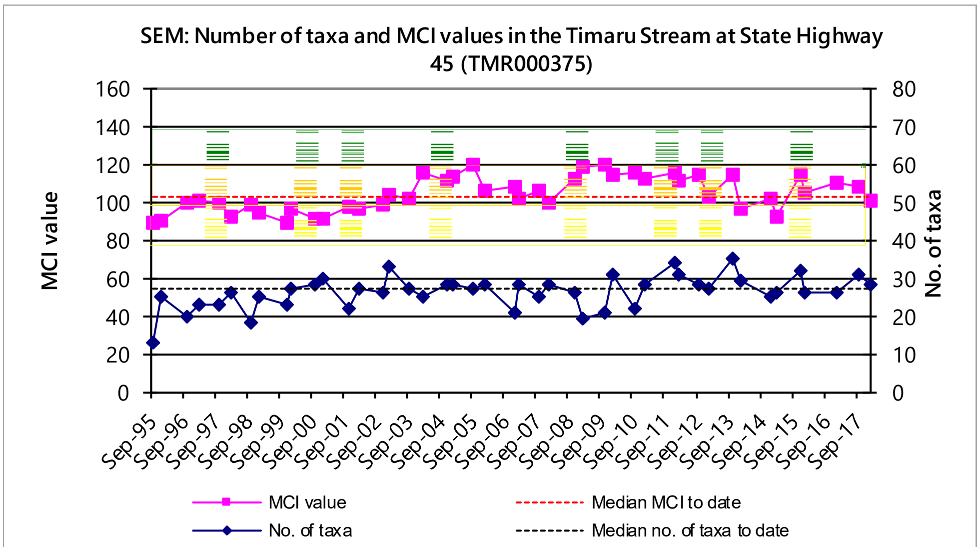


Figure 78 Numbers of taxa and MCI values in the Timaru Stream at State Highway 45

An unusually wide range of richness (13 to 35 taxa) has been found with a median richness of 26 taxa (higher than typical richness in the mid reaches of ringplain streams and rivers (TRC, 2017b)). During the 2017-2018 period spring (31 taxa) and summer (28 taxa) richness was up to five taxa higher than the historical median taxa number.

MCI values have had a slightly wider range (31 units) at this site than typical of sites in the mid reaches of ringplain streams. The median value (103 units) was very similar to the median calculated from mid reach sites on the ringplain. The spring 2017 (108 units) and summer 2018 (101 units) scores were not significantly different (Stark, 1998) to the historical median. The score categorised this site as having 'good' health generically (Table 3). The historical median score (103 units) placed this site in the 'good' category for the generic health.

3.2.6.2.2 Predicted stream 'health'

The Timaru Stream at SH45 is 10.9 km downstream of the National Park boundary at an altitude of 100 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 105 for this site. The historical site median, spring and summer scores were not significantly different to the predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 117 units. The historical site median and summer score were significantly lower than this value, while the spring score was not significantly different to this value.

3.2.6.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 79). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Timaru Stream at SH45.

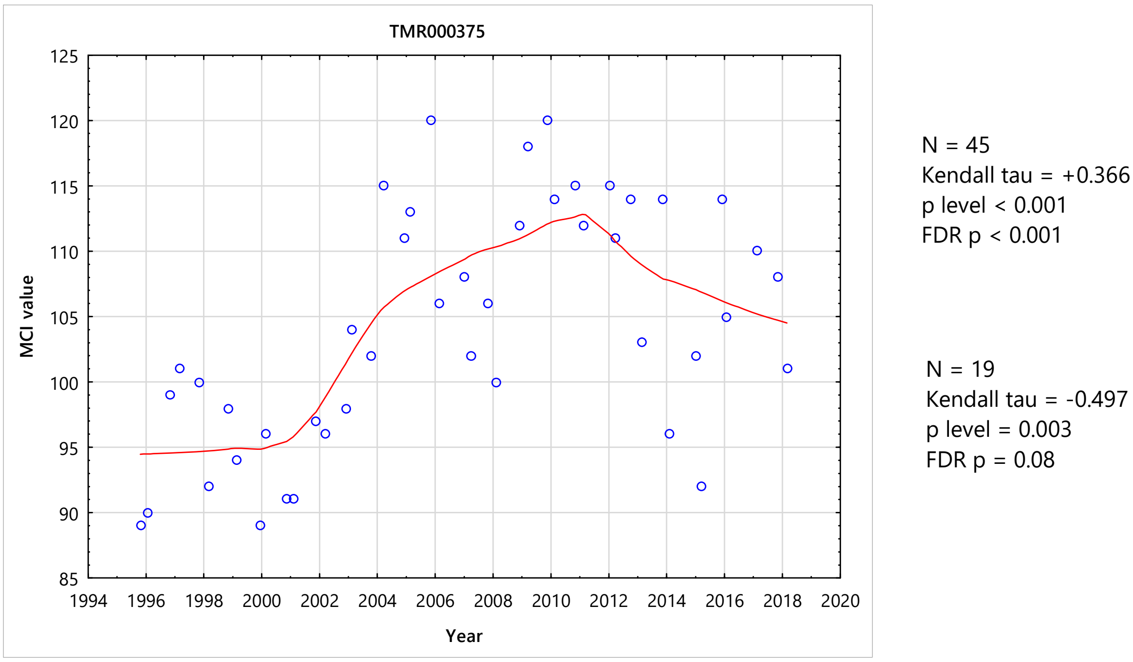


Figure 79 LOWESS trend plot of MCI data at the SH45 site for the full dataset with Mann-Kendall test for the full and ten-year dataset

MCI scores have shown a strong improvement over time (highly statistically significant), particularly since 2001, with most of the more recent scores (since 2004) well above scores recorded toward the start of the monitoring period. The trendline had a range over 19 units, an ecologically important range. The trendline indicated an improvement in generic stream 'health' (Table 3) from 'fair' to 'good'.

In contrast to the full dataset, the ten-year period showed a strong declining trend. This trend was not statistically significant after FDR adjustment.

3.2.6.3 Discussion

The spring and summer surveys indicated that the upper site had 'very good' health while the lower site had 'good' health.

The MCI scores fell in a downstream direction by 32 units in spring and by 35 units in summer, over a stream distance of 10.9 km downstream from the National Park boundary. This was typical for Timaru Stream and was likely due to the cumulative impacts of diffuse and point source inputs causing nutrient enrichment at the bottom site.

Time trend analysis indicated no change in macroinvertebrate community health over the full or ten-year dataset for the upper site while the lower site showed a significant positive improvement over the full 23 year time period. More recently, the ten-year period shows a non-significant declining trend at this site. No obvious explanations have been apparent for the positive trend but a possible reason may be related to improved management of dairy shed wastes disposal in the catchment above this SH45 site. No significant trend occurred over the more recent, ten-year period.

3.2.7 Waiau Stream

The Waiau Stream is a small, lowland stream flowing south to north with a mouth situated east of Waitara. One SEM site is located in the mid reach of the stream. The results found by the spring 2017 and summer 2018 surveys are presented in Table 102, Appendix I.

3.2.7.1 Inland North site (WAI000110)

3.2.7.1.1 Taxa richness and MCI

Thirty-six surveys have been undertaken in this mid-reach site in the Waiau Stream between February 1998 and February 2017. These results are summarised in Table 44, together with the results from the current period, and illustrated in Figure 80.

Table 44 Results of previous surveys performed in Waiau Stream at Inland North Road, together with the 2017-2018 results

Site code	SEM data (1998 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WAI000110	36	17-30	21	80-101	91	21	101	25	79

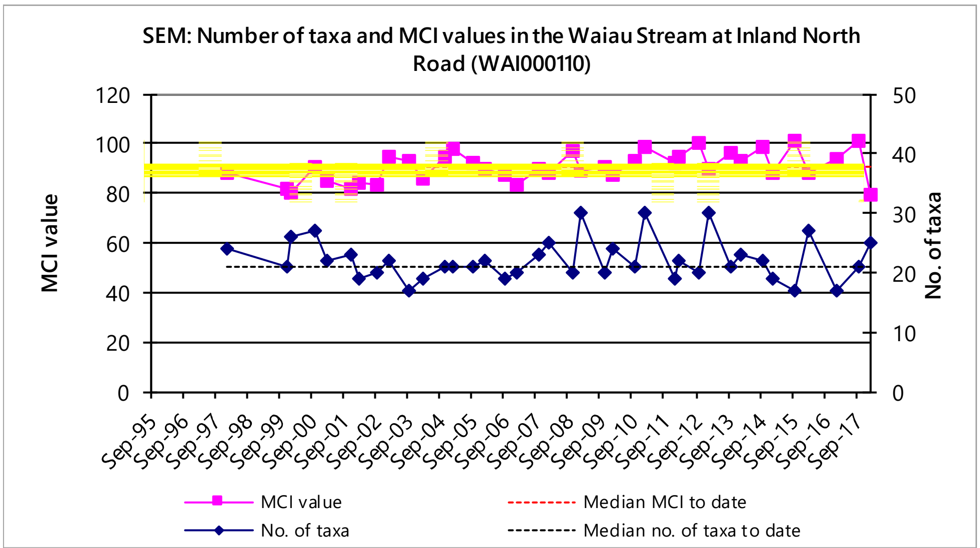


Figure 80 Numbers of taxa and MCI values in the Waiau Stream at the Inland North Road site

A moderate range of richness (17 to 30 taxa) has been found, with a median richness of 21 taxa (more representative of typical richness in small lowland coastal streams where a median richness of 20 taxa has been recorded from 128 previous surveys of 'control' sites at similar altitudes (TRC, 2017b)). During the 2017-2018 period, the spring (21 taxa) and summer (25 taxa) richness was similar to the median richness.

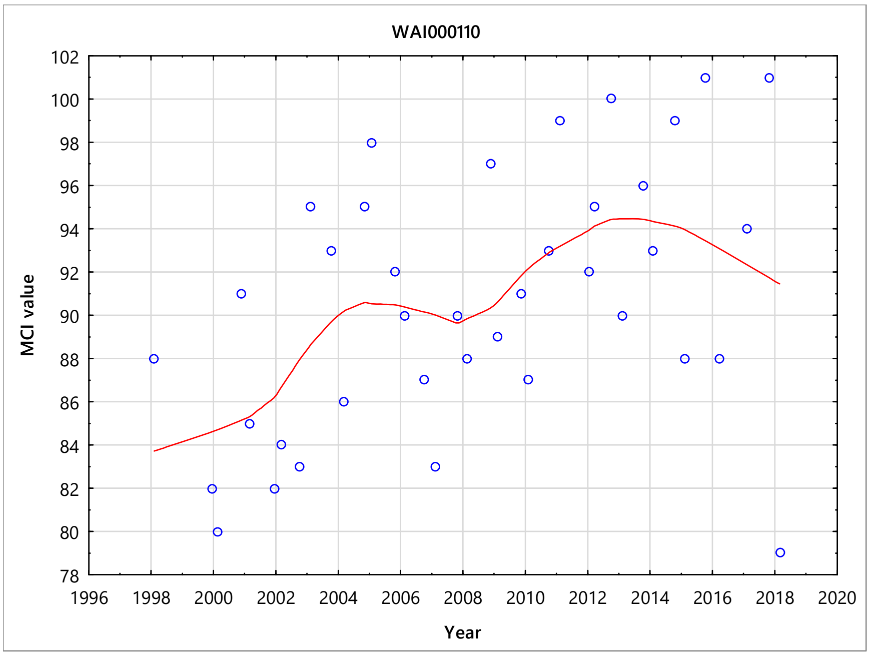
MCI values have had a moderate range (21 units) to date at this site. The median value (91 units) is more typical of scores at sites in the lower reaches of small lowland streams and rivers. The spring (101 units) score though not significantly higher than the historic median was equal to the the highest score recorded at this site to date. The summer (79 units) score was significantly lower than the historical median and was the lowest score recorded at this site to date. The score categorised this site as having 'good' (spring) and 'poor' (summer) health (Table 3). The historical median score (91 units) placed this site in the 'fair' category for the generic method of assessment.

3.2.7.1.2 Predicted stream 'health'

The Waiau Stream rises at an elevation of less than 100 m asl as seepage beyond the ringplain and the site at Inland North Road is in the mid reaches at an altitude of 50 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 91 units. The historical site median and spring scores were not significantly different from the REC predicted value, while the summer score was significantly lower than this value.

3.2.7.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 81). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 20 years of SEM results (1998-2018) and the most recent ten-years of results (2008-2018) from the site in the Waiau Stream at Inland North Road.



N = 38
Kendall tau = +0.345
p level = 0.002
FDR p = 0.010

N = 19
Kendall tau = +0.077
p level = 0.645
FDR p = 0.78

Figure 81 LOWESS trend plot of MCI data at the Inland North Road site, Waiau Stream for the full dataset with the full and ten-year dataset

A significant positive temporal trend in MCI scores has been found (FDR p = 0.01) over the 20 year monitoring term at this site. The trend had two dips where scores declined and the current period is in the second of the two dips. The trendline range of scores (11 units) has been of significant ecological importance. Trendline scores have been indicative of 'fair' generic stream health (Table 3) throughout the period.

The ten-year period, shows a small positive trend, which is neither staticially or ecologically significant. The smaller magnitiude of this trend is related to the more recent dip in MCI scores.

3.2.7.2 Discussion

Taxa richness was moderate and equal to or slightly higher than the previously recorded median for this site in spring and summer respectively.The spring survey indicated that the macroinvertebrate community was in 'good' health, equalling the highest score previously recorded at this site. In contrast, the summer MCI score indicated 'poor' health and was the lowest score recorded at this site to date. This seasonal variation was probably due to the very low flows that occurred during the summer period.

3.2.8 Waimoku Stream

The Waimoku Stream is a small ringplain stream with a source inside Egmont National Park in the Kaitake Ranges and flows in an east to west direction. There are two SEM sites situated on the stream in the upper and lower reaches. The results found by the 2017-2018 surveys are presented in Table 103 and Table 104, Appendix I.

3.2.8.1 Lucy's Gully site (WMK000100)

3.2.8.1.1 Taxa richness and MCI

Thirty-five surveys have been undertaken at this upper reach site in the Kaitake Ranges between December 1999 and February 2017. These results are summarised in Table 45, together with the results from the current period, and illustrated in Figure 82.

Table 45 Results of previous surveys performed in the Waimoku Stream at Lucy's Gully, together with the 2017-2018 results

Site code	SEM data (1999 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2017	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WMK000100	35	22-38	31	121-141	131	29	128	33	125

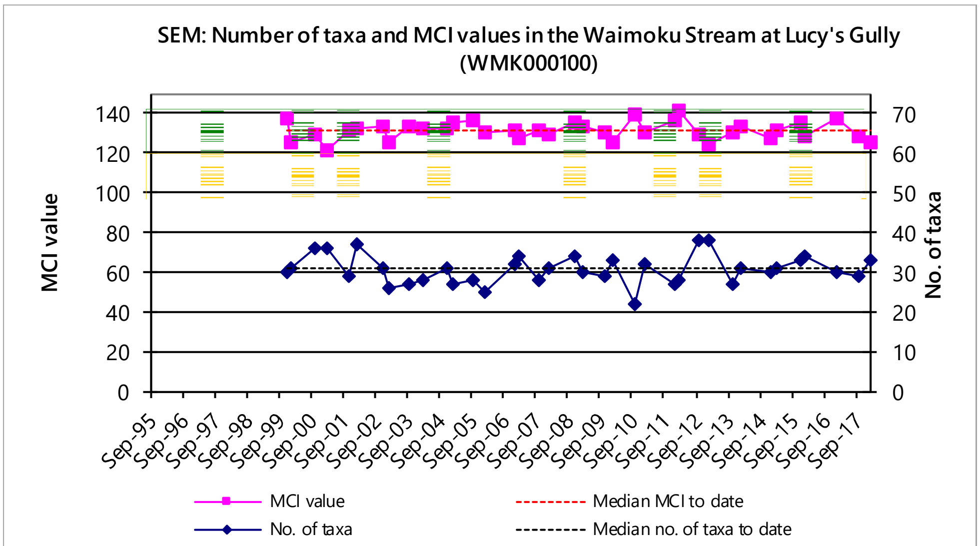


Figure 82 Numbers of taxa and MCI values in the Waimoku Stream at Lucy's Gully

A moderate range of richness (22 to 38 taxa) has been found, with a median richness of 31 taxa which is more representative of typical richness in the upper reaches of ringplain streams and rivers. During the 2017-2018 period the spring (29 taxa) and summer (33 taxa) richness were very similar to the historical median richness.

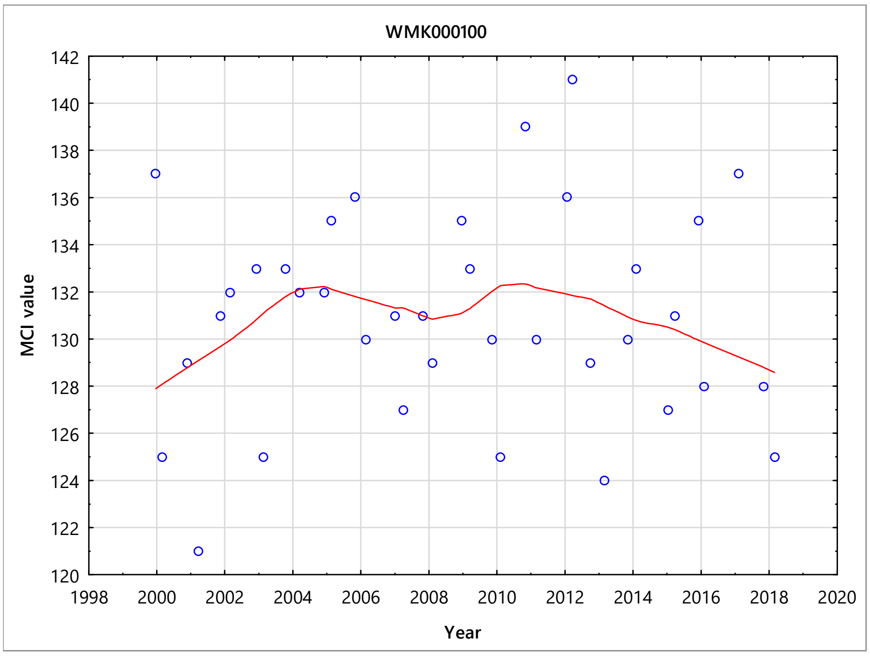
MCI values also have had a moderate range (20 units) at this site, slightly wider than typical of a site in the upper reaches of a ringplain stream. The median value (131 units) however, has been typical of upper reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (128 units) and summer 2018 (125 units) scores were not significantly different from the historical median (Stark, 1998). This score categorised this site as having 'very good' health generically (Table 3). The historical median score (131 units) placed this site in the 'very good' health category.

3.2.8.1.2 Predicted stream 'health'

The Waimoku Stream site at Lucy's Gully is within the Kaitake Ranges of the National Park boundary but at an altitude of 160 m asl and only 4 km from the coast. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median (131 units) was only one unit less than the distance predictive value. The spring (128 units) and summer (125 units) scores were also not significantly different from the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 128 units. The historical site median, sping and summer scores were not significantly different to the REC predictive score.

3.2.8.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 83). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 19 years of SEM results (1999-2018) and the most recent ten-years of results (2008-2018) from the site in the Waimoku Stream at Lucy's Gully.



N = 37
Kendall tau = -0.020
p level = 0.861
FDR p = 0.9

N = 19
Kendall tau = -0.179
p level = 0.284
FDR p = 0.59

Figure 83 LOWESS trend plot of MCI data at the Lucy's Gully site, Waimoku Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

No significant trend in MCI scores has been found over the 19 year period at this pristine site within the National Park. The trendline range of scores (five units) has not been ecologically important and these MCI scores have continuously indicated 'very good' generic stream health (Table 3).

The ten-year period also shows a weak negative trend that is not statistically or ecologically significant.

3.2.8.2 Oakura Beach site (WMK000298)

3.2.8.2.1 Taxa richness and MCI

Thirty-five surveys have been undertaken at this lower reach site at Oakura Beach in the Waimoku Stream between December 1999 and February 2017. These results are summarised in Table 46, together with the results from the current period, and illustrated in Figure 84.

Table 46 Results of previous surveys performed in the Waimoku Stream at Oakura Beach together with 2017-2018 results

Site code	SEM data (1999 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WMK000298	35	10-29	21	75-105	92	18	101	18	94

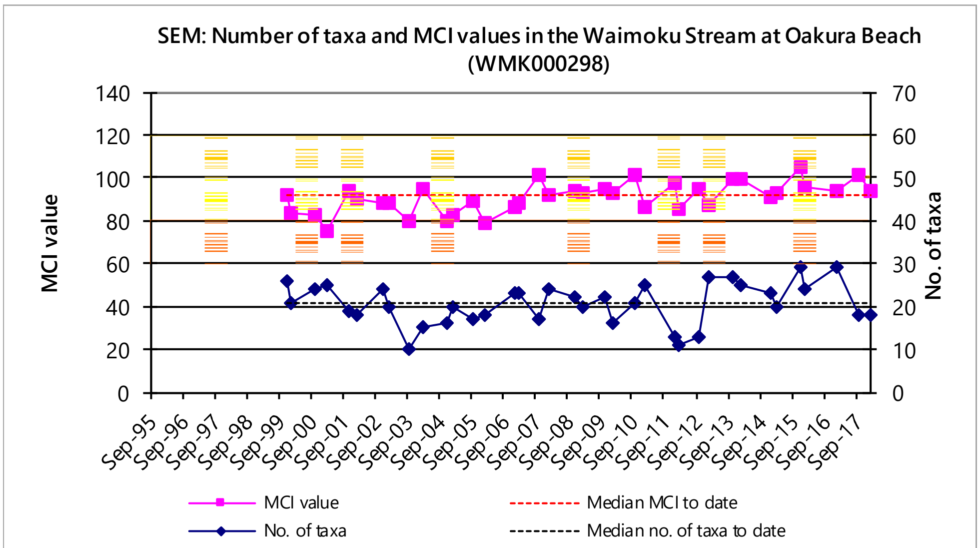


Figure 84 Numbers of taxa and MCI values in the Waimoku Stream at Oakura Beach

A wide range of richness (10 to 29 taxa) has been found; wider than might be expected, with a median richness of 21 taxa which was more representative of typical richness in ringplain streams and rivers in the lower reaches. During the 2017-2018 period, spring (18 taxa) and summer (18 taxa) richness was three taxa less than the median taxa richness.

MCI scores have had a relatively wide range (30 units) at this site, typical of sites in the lower reaches of ringplain streams. The spring 2017 (101 units) and summer 2018 (94 units) scores were not significantly different to the historical median, although the spring score was equal to the second highest score recorded at this site to date. The scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score categorised the site as having 'fair' health generically.

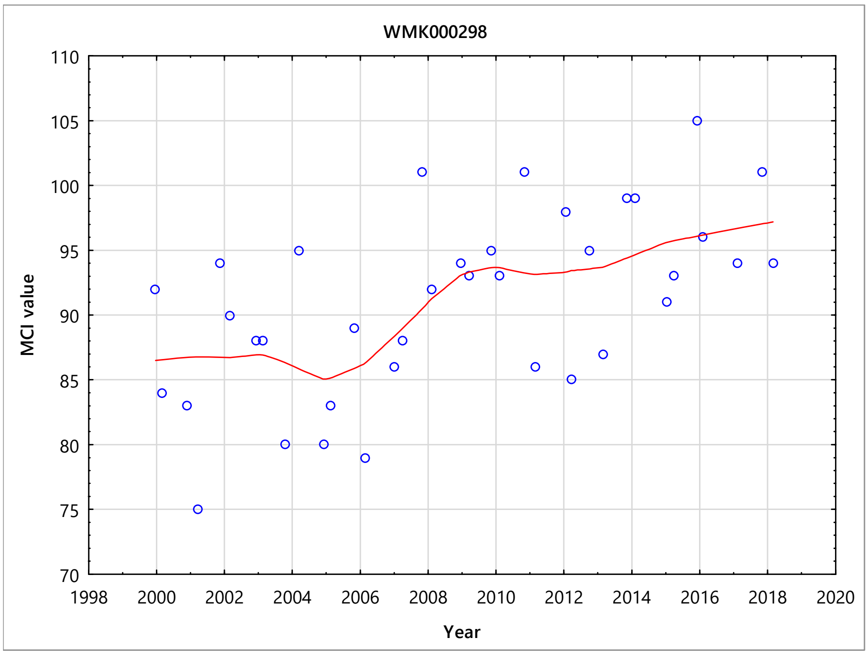
3.2.8.2.2 Predicted stream 'health'

The Waimoku Stream at Oakura Beach site at an altitude of 1 m asl is only 4 km downstream of the National Park boundary. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 116 for this site. The historical site median (92 units) is a significant 24 units lower than the predictive distance value, due to the atypically short distance between the National Park boundary and the coast for a ringplain stream. The spring 2017

(101 units) and summer 2018 (94 units) scores were also significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 103 units. The historical site median was significantly lower than the REC predictive value but the spring and summer scores were not significantly different.

3.2.8.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 85). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 19 years of SEM results (1999-2018) and the most recent ten-years of results (2008-2018 from the site in the Waimoku Stream at Oakura Beach.



N = 37
Kendall tau = +0.402
p level < 0.001
FDR p < 0.001

N = 19
Kendall tau = +0.180
p level = 0.281
FDR p = 0.59

Figure 85 LOWESS trend plot of MCI data at the Oakura Beach site, Waimoku Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

An overall positive significant trend in MCI scores has been recorded during the 19 year monitoring period (FDR $p < 0.01$) indicating an improvement in macroinvertebrate health. The trendline range of scores (12 units) has been ecologically important and has consistently indicated 'fair' generic stream health at this site in the lower reaches of the stream.

The ten-year period also shows a positive trend, however this is neither ecologically or statistically significant.

3.2.8.3 Discussion

Taxa richness were moderatey high at the upper site and moderate at the lower site.The sping survey indicated that the macroinvertebrate community at the upper site was in 'very good' health with the lower site was in 'good' health, while the summer survey indicated 'very good' and 'fair' health at these sites respectively. Macroinvertebrate health was typical for both sites. The MCI score fell in a downstream direction in spring and summer by 27 and 31 units respecitively, over a short stream distance of only 4.0 km downstream from the National Park boundary. This was a large decrease in condition for a relatively short distance and greater than what would be expected given the relatively intact upper catchment. This may be due to significant nutrient enrichment and/ or habitat degradation at the lower site.

The time trend analysis indicated no trends at the upper site which would be expected given its pristine nature. The lower site had a significant positive trend over the full dataset indicating that macroinvertebrate health had improved though improvements may have plateaued over the last ten-years. Increases in the amount of riparian fencing and planting of waterways in the catchment have probably contributed to this improvement.

3.2.9 Waingongoro River

The Waingongoro River is a large ringplain river with a source inside Egmont National Park. The river flows approximately north to south and there are six SEM sites situated along the length of the river. The results of the 2017-2018 surveys are summarised in Table 105 and Table 106, Appendix I.

3.2.9.1 Site near National Park boundary (WGG000115)

3.2.9.1.1 Taxa richness and MCI

Forty-four 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 2017. These results are summarised in Table 47, together with the results from the current period, and illustrated in Figure 86.

Table 47 Results of previous surveys performed in the Waingongoro River 700m downstream of the National Park, together with 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000115	44	23-40	31	122-144	132	26	135	27	134

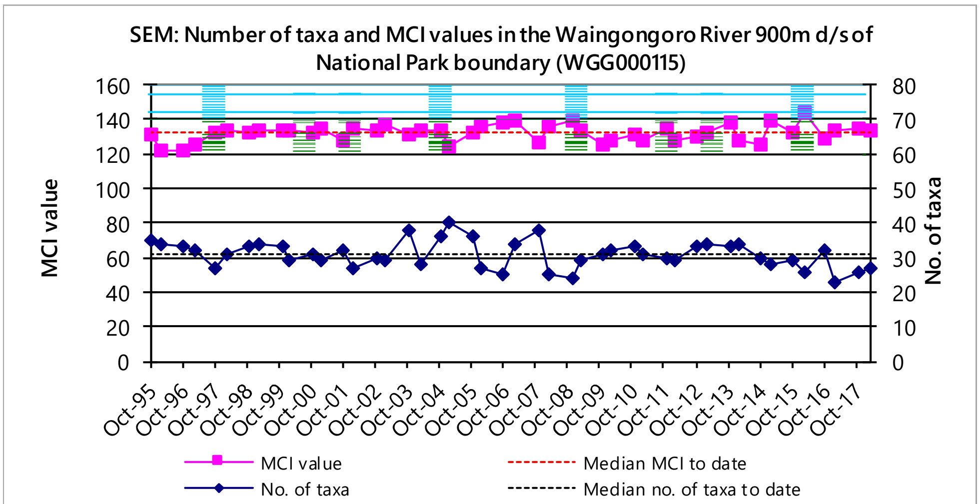


Figure 86 Numbers of taxa and MCI values in the Waingongoro River 700 m d/s National Park

A relatively wide range of richness (23 to 40 taxa) has been found with a high median richness of 31 taxa, typical of richness in ringplain streams and rivers near the National Park boundary. During the 2017-2018 period, spring (26 taxa) and summer (27 taxa) richness were slightly less than the historical median.

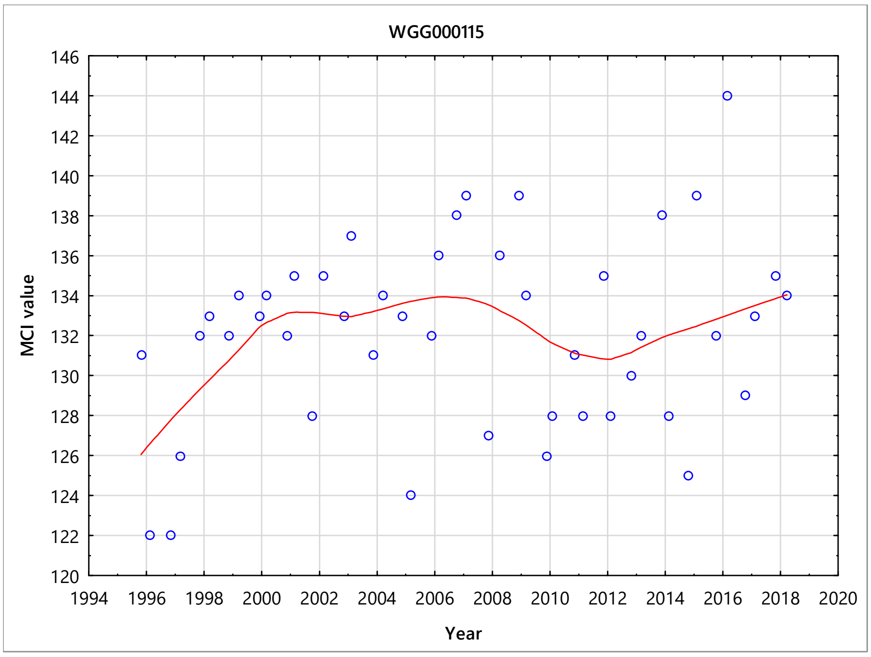
MCI values have had a moderate range (22 units) at this site, typical of a National Park boundary site. The median value (132 units) has also been typical of upper reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (135 units) and summer 2018 (134 units) scores were not significantly different from the historical median. The MCI scores categorised this site as having 'very good' health generically (Table 3). The historical median score (132 units) placed this site in the 'very good' category for generic health.

3.2.9.1.2 Predicted stream 'health'

The Waingongoro River site near the National Park is 0.7 km downstream of the National Park boundary at an altitude of 540 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median, spring and summer scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 131 units. The historical median, spring and summer and scores were also all not significantly different to this value.

3.2.9.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 87). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waingongoro River near the National Park.



N = 46
Kendall tau = 0.149
p value = 0.143
FDR p = 0.220

N = 20
Kendall tau = 0.184
p value = 0.257
FDR p = 0.590

Figure 87 LOWESS trend plot of MCI data at the site near the National Park, Waingongoro River

A positive, non-significant trend has been found over the 23-year period. This has not been statistically significant, although previously (prior to 2008) there had been a statistically significant improvement over the earlier period (1995-2007). After 2007 there was some decline followed by some very recent improvement but the overall trendline range of scores (eight units) remains less than ecologically important. Throughout the period, the trend has indicated 'very good' generic river health.

Congruent with the full dataset there was a non-significant postive trend in MCI scores over the most recent ten-year period after FDR, with an increase in the trendline from 2012 onwards. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.9.2 Opunake Road site (WGG000150)

3.2.9.2.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Waingongoro River at this upper mid-reach site at Opunake Road (approximately 7km downstream of the National Park) between October 1995 and March 2017. These results are summarised in Table 48, together with the results from the current period, and illustrated in Figure 88.

Table 48 Results of previous surveys performed in the Waingongoro River at Opunake Road together with 2017-2018 results.

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000150	44	22-39	27	119-139	129	25	130	24	124

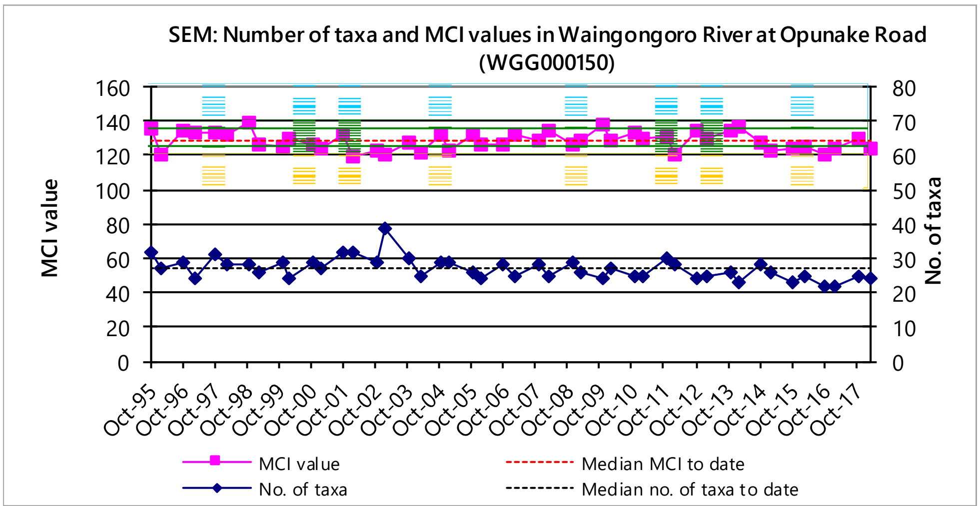


Figure 88 Numbers of taxa and MCI values in the Waingongoro River at Opunake Road

A relatively wide range of richness (22 to 39 taxa) has been found; wider than might be expected, with a median richness of 27 taxa (more representative of typical richness in the upper mid reaches of ringplain streams and rivers). During the 2017-2018 period spring (25 taxa) and summer (24 taxa) richness were slightly lower than the historical median.

MCI values have had a moderate range (20 units) at this site, typical of sites in the upper mid reaches of ringplain rivers. The median value (129 units) has been higher than typical of upper, mid reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (130 units) and summer 2018 (124 units) scores were not significantly lower than the median value (Stark, 1998). These scores categorised this site as having ‘very good’ (spring and summer) health generically (Table 3). The historical median score placed this site in the ‘very good’ category for generic health.

3.2.9.2.2 Predicted stream health

The Waingongoro River at Opunake Road is 7.2km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict an MCI value of 110 for this sites. The historical site median, spring and summer scores were significantly higher (Stark, 1998). The REC predicted MCI value

(Leathwick, et al. 2009) was 124 units. The historical site median, spring and summer values were not significantly different from this value.

3.2.9.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 89). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waingongoro River at Opunake Road.

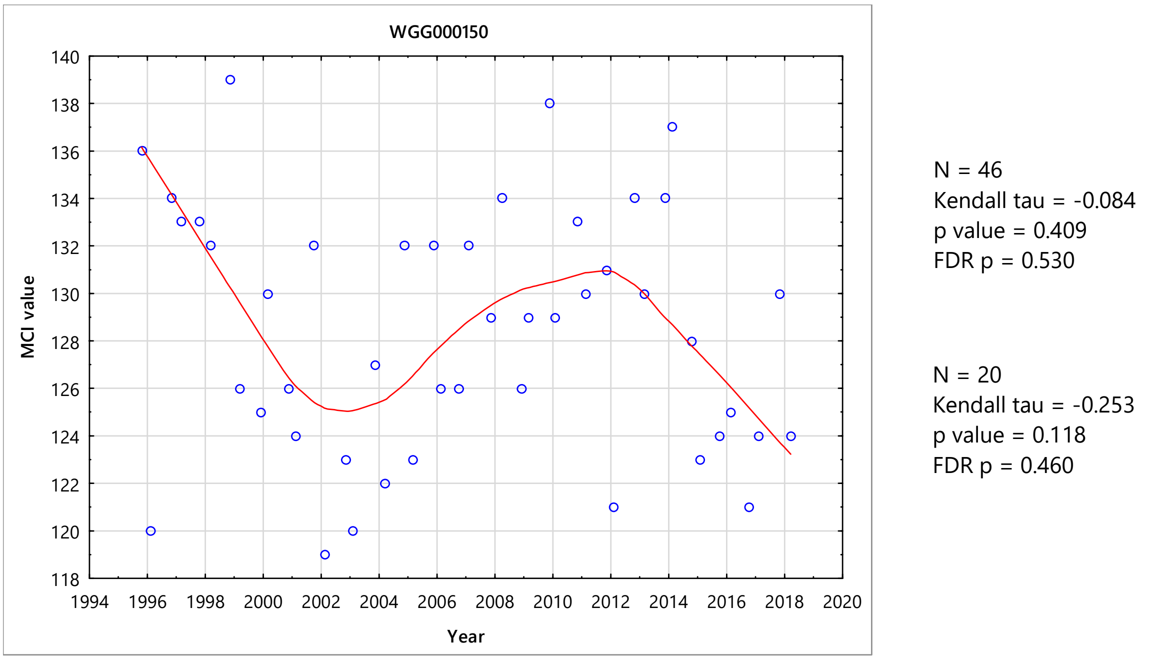


Figure 89 LOWESS trend plot of MCI data at the Opunake Road site, Waingongoro River

A non-significant negative trend in MCI scores has occurred in the upper mid-reaches of the river (some seven km below the National Park). The trendline range of scores (13 units) has been of minor ecological importance over the 23 year period. Localised erosion had caused sediment deposition on the riverbed during 1999 with a subsequent five year decline in MCI scores. This decline ceased with a gradual improvement in MCI scores towards earlier levels over the latter twelve years. The erosion event was very localised and site specific, as corresponding biological and physiochemical monitoring data showed no significant trends at the nearest downstream site (Eltham Road). The trendline has again started to decline from 2012 onwards, possibly due to erosion again. The trendline range of scores have been consistently indicative of 'very good' generic river health.

Congruent with the full dataset, there was a non-significant, but stronger, negative trend in MCI scores over the most recent ten-year period, with a decrease in the trendline from 2012 onwards. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.9.3 Eltham Road site (WGG000500)

3.2.9.3.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Waingongoro River at this mid-reach site at Eltham Road between October 1995 and March 2017. These results are summarised in Table 49, together with the results from the current period, and illustrated in Figure 90.

Table 49 Results of previous surveys performed in the Waingongoro River at Eltham Road, together with 2017-2018 results.

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000500	44	16 - 32	22	91-124	103	15	125	22	112

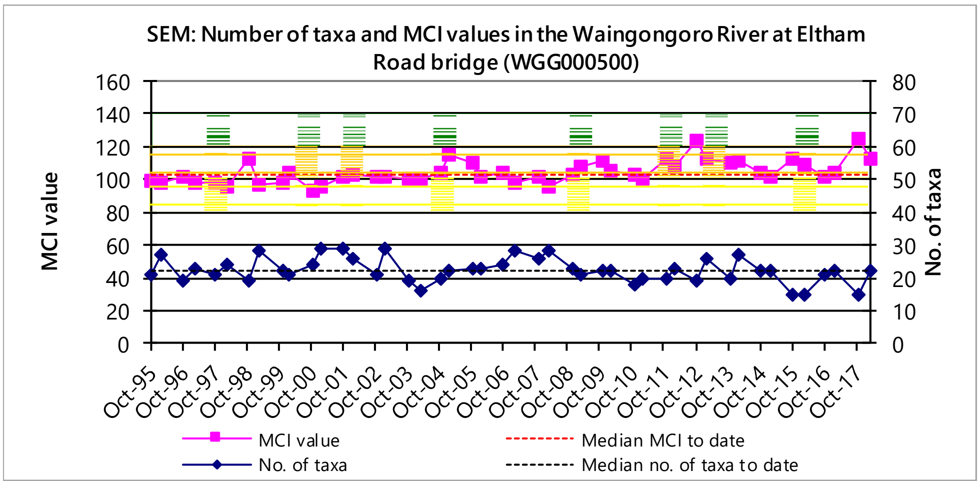


Figure 90 Numbers of taxa and MCI values in the Waingongoro River at Eltham Road

A wide range of richness (16 to 32 taxa) has been found with a median richness of 22 taxa, typical of richness in the mid reaches of ringplain streams and rivers. During the 2017-2018 period spring (15 taxa) richness was slightly lower and summer (22 taxa) richness the same as the historical median.

MCI values have had a relatively wide range (33 units) at this site, more typical of sites in the mid reaches of ringplain rivers. The historical median value (103 units) has been typical of mid reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (125 units) scpre was significantly higher than the historic median and a new maximum score for the site by one unit while the summer 2018 (112 units) score was not significantly different to the historical median. These scores categorised this site as having 'very good' (spring) and 'good' (summer) health generically (Table 3). The historical median score (103 units) placed this site in the 'good' category for generic health.

3.2.9.3.2 Predicted stream 'health'

The Waingongoro River site at Eltham Road is 23.0 km downstream of the National Park boundary at an altitude of 200 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 97 for this site. The historical site median score was not significantly different to the distance predictive value and the spring and summer scores were both significantly higher (Stark, 1998).

The median value for a ringplain river arising within the National Park at similar altitude (TRC, 2017b) was 101 units. The historical site median score was not significantly different to the median value and the spring and summer scores were both significantly higher. The REC predicted MCI value (Leathwick, et al. 2009) was 110 units. The historical median and summer scores were not significantly different to this value and the spring score was significantly higher.

3.2.9.3.3 Temporal trends in 1995 to 2018 data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 91). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waingongoro River at Eltham Road.

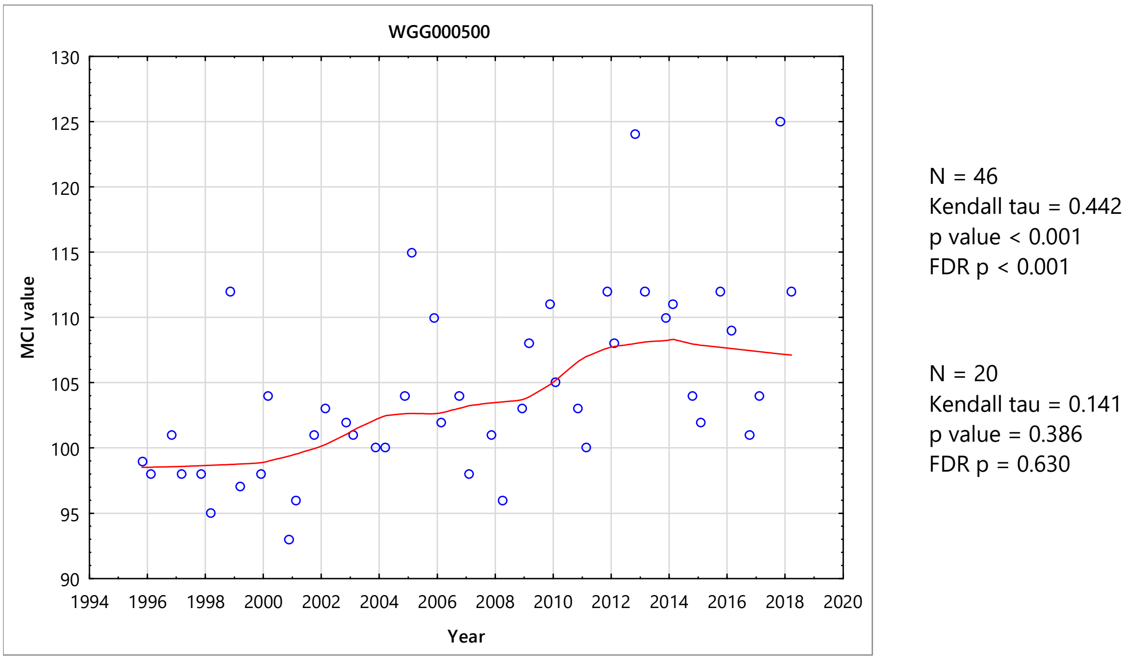


Figure 91 LOWESS trend plot of MCI data at the Eltham Road site, Waingongoro River

A significant positive temporal trend in MCI scores has been found over the 23-year period (FDR p< 0.01). This has been more pronounced since 2001 but scores plateaued for about three years before a more recent further improvement and another most recent plateau in scores. The trendline range of scores (10 units) has been of marginal ecological importance over the 23 year period due to the recent plateau in scores. The trendline MCI scores wre indicative of 'fair' generic health prior to 2002 and since then have been in the 'good' category.

Congruent with the full dataset, there was a non-significant, postive trend in MCI scores over the most recent ten-year period. The trendline for the most recent ten-year period was indicative of 'good' health.

3.2.9.4 Stuart Road site (WGG000665)

3.2.9.4.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Waingongoro River at this mid-reach site at Stuart Road between October 1995 and Febuary, 2017. These results are summarised in Table 50, together with the results from the current period, and illustrated in Figure 92.

Table 50 Results of previous surveys performed in the Waingongoro River at Stuart Road, together with spring 2017 and summer 2018 results

Site code	SEM data (1995 to Febuary 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000665	44	14 - 30	20	77-111	96	19	101	15	89

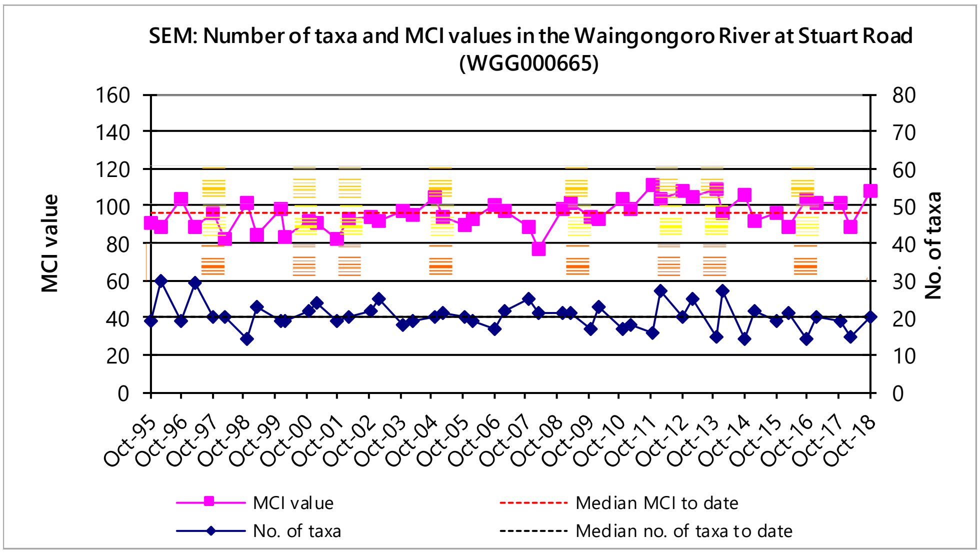


Figure 92 Numbers of taxa and MCI values in the Waingongoro River at Stuart Road

A wide range of richness (14 to 30 taxa) has been found with a median richness of 20 taxa (more representative of typical richness in the mid reaches of ringplain streams and rivers). During the 2017-2018 period spring (19 taxa) and summer (15 taxa) richness were very similar to the historical median (20 taxa).

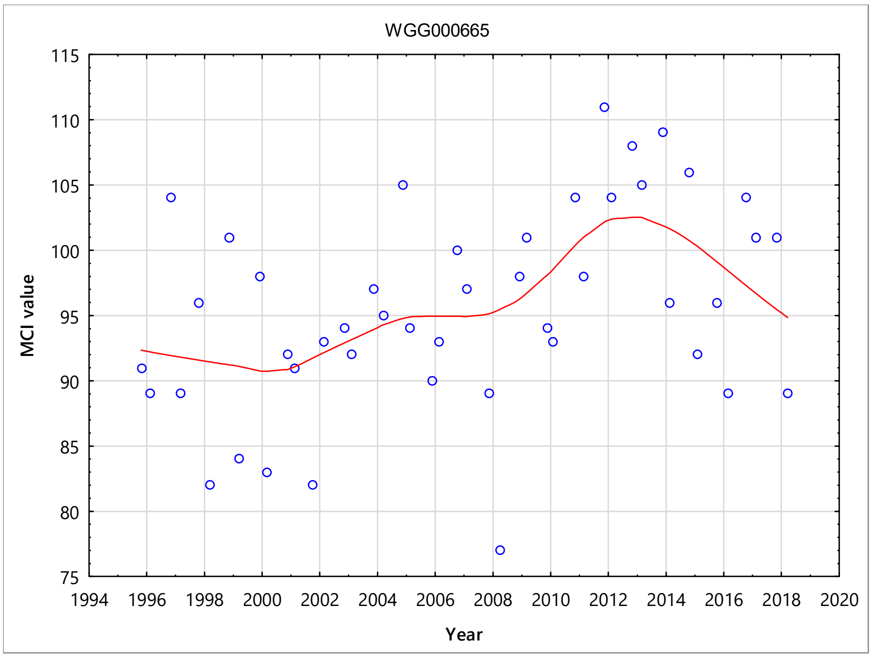
MCI values have had a moderately wide range (34 units) at this site, typical of sites in the mid reaches of ringplain rivers. The median value (96 units) has been lower than typical of mid reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (101 units) and summer 2018 (89 units) scores were not significantly different to the historical median. These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (96 units) placed this site in the 'fair' category for generic health.

3.2.9.4.2 Predicted stream 'health'

The Waingongoro River site at Stuart Road is 29.6 km downstream of the National Park boundary at an altitude of 180 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value of 94 for this site. The historical site median, spring and summer survey scores were all not significantly different to the distance predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 102 units. The historical median and spring scores were not significantly different to the REC predictive value but the summer score was significantly lower (Stark, 1998).

3.2.9.4.3 Temporal trends in 1995 to 2018 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 93). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waingongoro River at Stuart Road.



N = 46
Kendall tau = 0.290
p value = 0.005
FDR p = 0.010

N = 20
Kendall tau = -0.113
p value = 0.485
FDR p = 0.700

Figure 93 LOWESS trend plot of MCI data at the Stuart Road site, Waingongoro River

A positive significant trend in MCI scores has been found over the 23 year period (FDR p = 0.01 application). There has been an improvement in MCI scores since 2002 (coincident with summer diversion of the treated meatworks wastes discharge at Eltham from the river to land irrigation) and particularly most recently (since 2009) following the diversion of treated municipal Eltham wastewater out of the catchment (to the Hawera WWTP and ocean outfall). However, since 2013 scores have declined sharply. The trendline range of scores (12 units) has also been ecologically important over the 23 year period. The trendline has been indicative of 'fair' generic river health apart from a brief period where it was at 'good' generic health from 2011 to 2015.

In constrast to the full dataset, there was a non-significant, negative trend in MCI scores over the most recent ten-year period, due to the decline in MCI scores since 2013. The trendline has been indicative of 'fair' generic river health apart from a brief period where it was at 'good' generic health from 2011 to 2015.

3.2.9.5 SH45 site (WGG000895)

3.2.9.5.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Waingongoro River at this lower reach site at SH45 between October 1995 and Febuary, 2017. These results are summarised in Table 51, together with the results from the current period, and illustrated in Figure 94.

Table 51 Results of previous surveys performed in the Waingongoro River at SH45, together with spring 2017 and summer 2018 results

Site code	SEM data (1995 to November 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000895	44	13 - 25	20	73-106	95	24	93	23	91

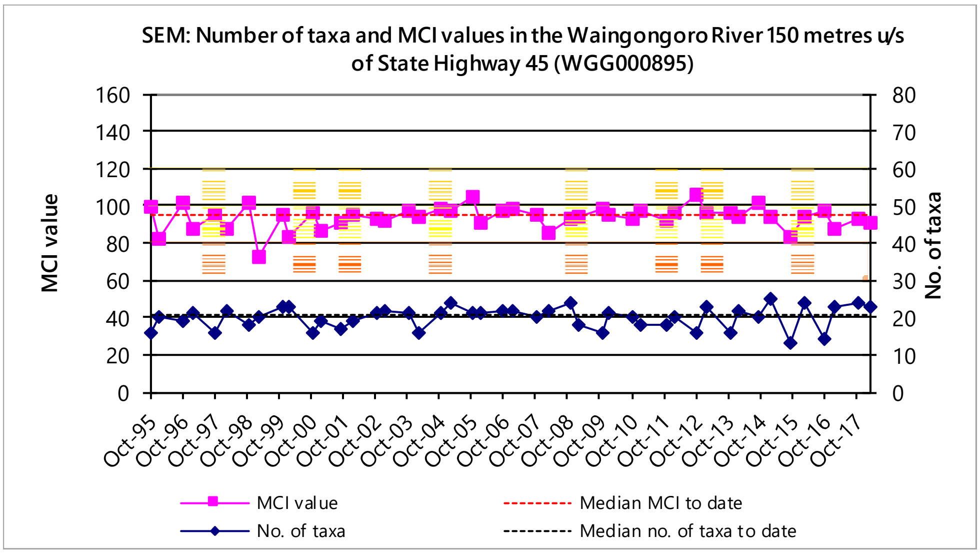


Figure 94 Numbers of taxa and MCI values in the Waingongoro River 150 m u/s of SH45

A moderate range of richness (13 to 25 taxa) has been found with a median richness of 20 taxa (more representative of typical richness in the lower reaches of ringplain streams and rivers). During the 2017-2018 period, spring (24 taxa) and summer (23 taxa) richness were similar to each and only slightly higher than the historical median (20 taxa).

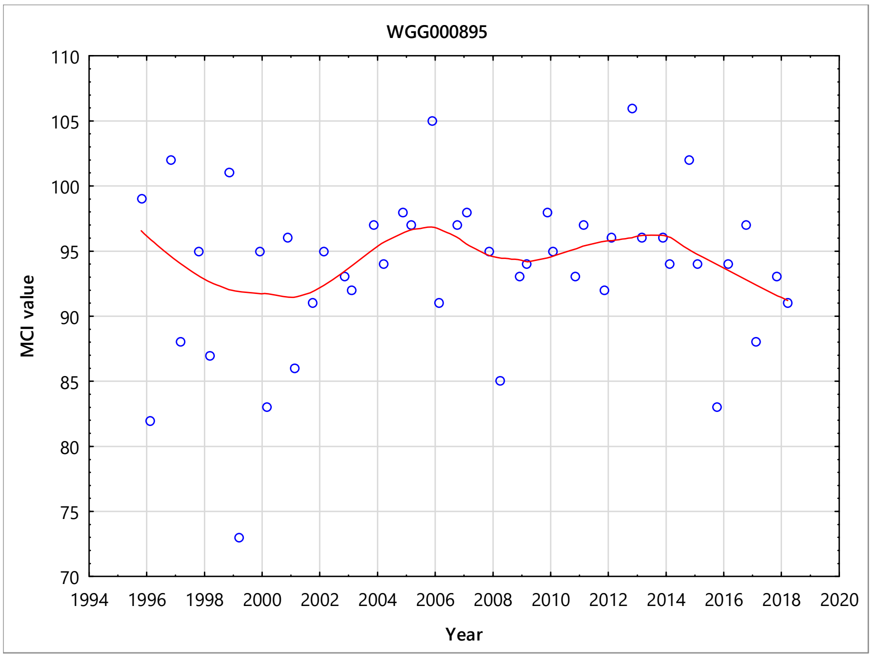
MCI values have had a wide range (33 units) at this site, more typical of sites in the lower reaches of ringplain streams and rivers. The median value (95 units) has been higher than typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (93 units) and summer (91 units) scores were not significantly different to the historical median. These scores categorised this site as having 'fair' health (spring and summer) generically (Table 3). The historical median score (95 units) placed this site in the 'fair' category for generic health.

3.2.9.5.2 Predicted stream 'health'

The Waingongoro River site at SH45 is 63.0 km downstream of the National Park boundary at an altitude of 40 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 85 for this site. The historical site median, spring and summers scores were not significantly different from the distance predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. Again, the historical, spring and summer scores were not significantly different to this value (Stark, 1998).

3.2.9.5.3 Temporal trends in 1995 to 2018 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 95). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waingongoro River at SH45.



N = 46
Kendall tau = 0.039
p value = 0.705
FDR p = 0.790

N = 20
Kendall tau = -0.191
p value = 0.239
FDR p = 0.570

Figure 95 LOWESS trend plot of MCI data for the SH45 site, Waingongoro River

A very small, positive trend in MCI scores has been found over the 23-year period. A general plateauing in the trend has occurred since 2005. The narrow trendline range (five units) of scores has not been ecologically important. The range of trendline scores have consistently indicated ‘fair’ generic river health throughout the period.

In constrast to the full dataset, there was a non-significant, negative trend in MCI scores over the most recent ten-year period, with a small increase from 2008 to 2014 followed by a slightly larger decrease in MCI scores. The trendline has been indicative of ‘fair’ generic river health over the most recent ten-year period.

3.2.9.6 Ohawe Beach site (WGG000995)

3.2.9.6.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Waingongoro River at this lower reach site at Ohawe Beach between October 1995 and February 2017. These results are summarised in Table 52, together with the results from the current period, and illustrated in Figure 96.

Table 52 Results of previous surveys performed in the Waingongoro River at the Ohawe Beach site, together with spring 2017 and summer 2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000995	44	12 - 25	18	69-100	91	16	80	22	89

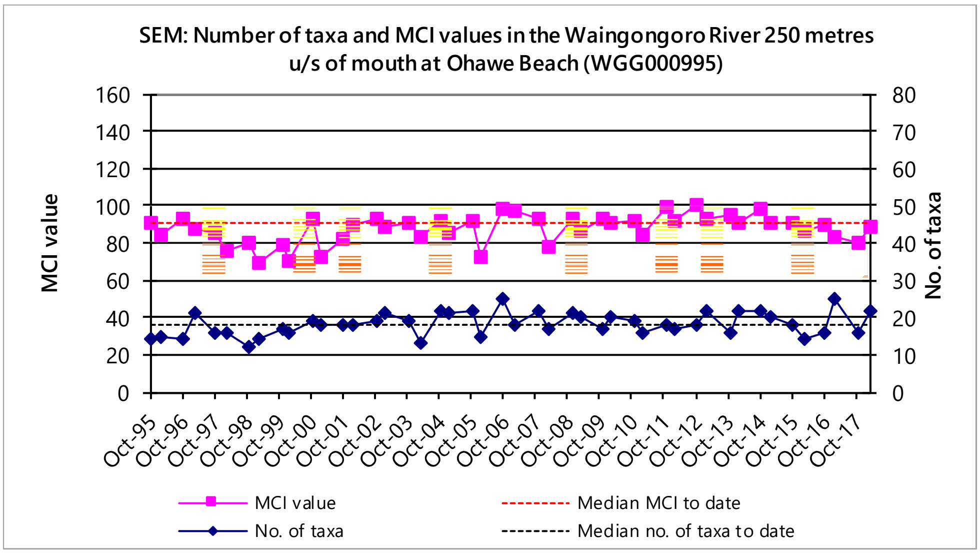


Figure 96 Numbers of taxa and MCI values in the Waingongoro River at the Ohawe Beach site

A wide range of richness (12 to 25 taxa) has been found, with a median richness of 18 taxa. During the 2017-2018 period, spring (16 taxa) and summer (22 taxa) richness were six taxa apart with the spring richness sligntly lower than the historical richness while the summer richness was slightly higher.

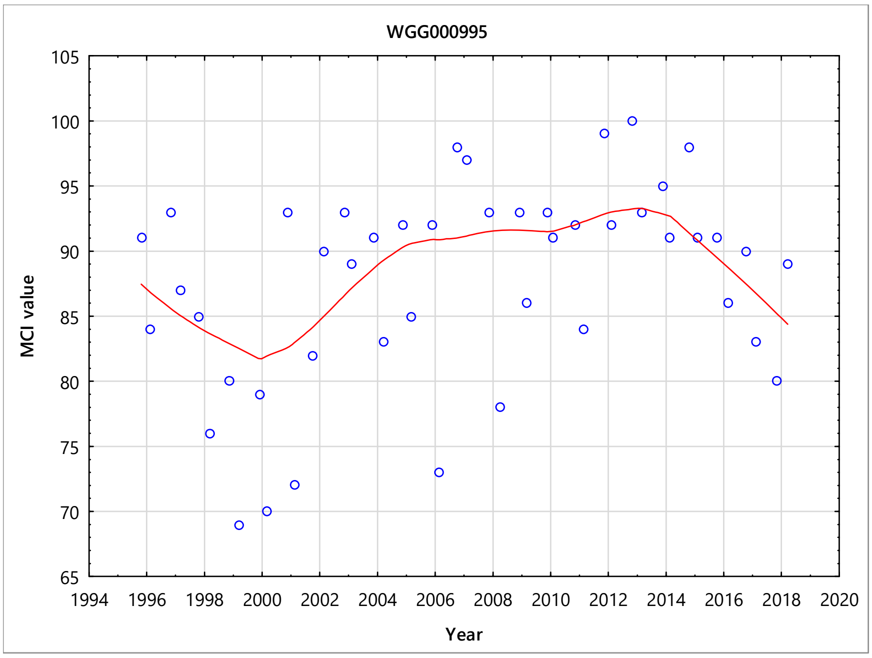
MCI values have had a relatively wide range (31 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been more typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (80 units) score was significantly lower than the historic median but the summer 2018 (89 units) score was very similar. These scores categorised this site as having 'fair' health generically in spring and summer (Table 3). The historical median score (91 units) placed this site in the 'fair' category for generic health.

3.2.9.6.2 Predicted stream 'health'

The Waingongoro River at the Ohawe Beach site is 66.6km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams and rivers developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of and 85 for this site. The historical, spring 2017 and summer 2018 scores were not significantly different to predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 95 units. The historical and summer scores were not significantly different to this value but the spring score was significantly lower (Stark, 1998).

3.2.9.6.3 Temporal trends in 1995 to 2018 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 97). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waingongoro River at Ohawe Beach.



N = 46
Kendall tau = 0.189
p value = 0.064
FDR p = 0.110

N = 20
Kendall tau = -0.331
p value = 0.041
FDR p = 0.360

Figure 97 LOWESS trend plot of MCI data at the Ohawe Beach site, Waingongoro River

There was a non-significant positive trend of MCI scores over the 23-year period ($p < 0.05$ after FDR application). There has been a marked improvement of MCI scores since 2001, which plateaued between 2006 and 2009, with a recent more gradual improvement. The trendline range of scores (11 units) has been ecologically important, mainly due to the influence of a series of low scores (<81 MCI units) between 1998 and 2001 and the elevation in scores subsequent to diversion of major mid-catchment point source discharges out of the river, particularly since 2009. Trendline scores were consistently indicative of 'fair' generic river health.

In constrast to the full dataset, there was a non-significant, negative trend in MCI scores over the most recent ten-year period. Before FDR application, the negative trend was significant. This was due to a sharp decrease after 2014. The trendline was still indicative of 'fair' generic river health but is heading towards 'poor' health.

3.2.9.7 Discussion

Taxa richness varied among sites and seasonally but no real trend was apparent between sites or between spring and summer.

The surveys indicated that the macroinvertebrate community at the upper two sites were in 'very good' health, the middle two sites were in 'good' to 'fair' health, and the bottom two sites were in 'fair' health. The MCI scores fell in a downstream direction between the upper site and the furthest downstream lower reaches site by 55 units in spring and 45 units in summer, over a river distance of 65.9 km. These seasonal falls in MCI scores were typical and always occurred to varying extents.

The time trend analysis indicated no significant trends at the upper two sites which would be expected given there relatively pristine nature. The middle two sites had significant positive trends over the full dataset indicating improvements in macroinvertebrate health but these improvements may have plateaued over the last ten-years. The lowest two sites had no significant trends though the lowest site had a significant negative trend before FDR application for the most recent ten-year period. Increases in the amount of riparian fencing and planting of waterways in the catchment as well as the removal of the Eltham wastewater discharge (lower middle site) have probably contributed to improvements in macroinvertebrate health in the middle catchment sites.

3.2.10 Waiokura Stream

Two sites in this small, intensively dairy-farmed, ringplain seepage-sourced stream, were included in the SEM programme in recognition of a long-term collaborative study of the effects of best-practice dairy-farming initiatives being evaluated in five dairying catchments throughout the country (Wilcock et al, 2009). Fonterra, Kapuni lactose factory also irrigates wastewater to land in the mid reaches of this catchment. One site is located upstream of the irrigation area (in mid-catchment) and the other site approximately ten km further downstream toward the lower reaches of the stream. Some consent monitoring data have been collected from the upper site since 2003 whereas the downstream site was established for biological temporal trend purposes in the 2008-2009 period to provide an additional monitoring component of the collaborative study.

The results of spring and summer (2017-2018) surveys are summarised in Table 107 and Table 108, Appendix I.

3.2.10.1 Skeet Road site (WKR000500)

3.2.10.1.1 Taxa richness and MCI

Twenty-five surveys have been undertaken, between 2003 and February 2017, at this mid-reach, partially shaded site in the Waiokura Stream, draining open developed farmland upstream of the Fonterra, Kapuni wastewater irrigation area. These results are summarised in Table 53, together with the results from the current period, and illustrated in Figure 98.

Table 53 Results of previous surveys performed in the Waiokura Stream at Skeet Road, together with 2017-2018 results

Site code	SEM data (2003 to Febuary 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000500	25	18 - 29	23	88-114	99	19	101	23	110

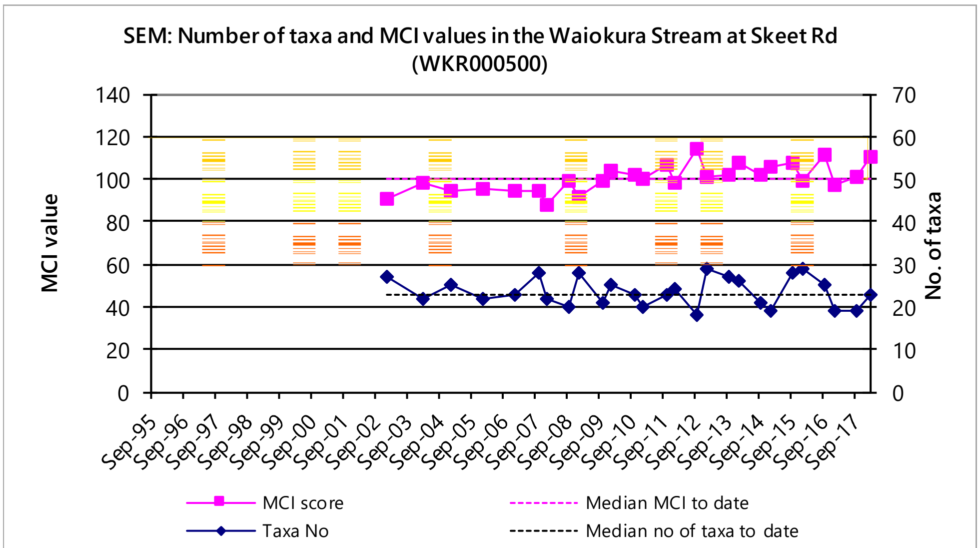


Figure 98 Numbers of taxa and MCI values in the Waiokura Stream at Skeet Road

A relatively narrow range of richness (18 to 29 taxa) has been found to date with a median richness of 23 taxa more typical of richness in the mid reaches of ringplain streams rising outside the National park boundary. During the 2017-2018 period spring (19 taxa) and summer (23 taxa) richness were similar to the historical median of 23 taxa.

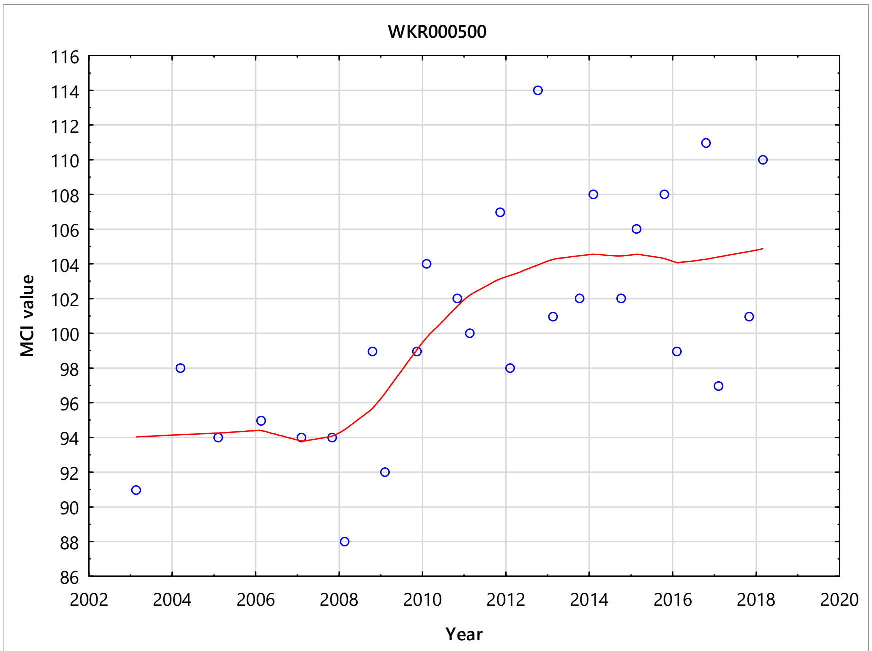
MCI values have had a moderate range (26 units) at this site, more typical of mid reach sites on the ringplain, although the monitoring period has been relatively short to date. The historical median value (99 units) has been typical of mid-reach sites in streams rising outside the National Park elsewhere on the ringplain (TRC, 2017b). The spring 2017 (101 units) score was not significantly different to the historical median and the summer 2018 (110 units) scores was significantly higher than the historical median (Stark, 1998). The scores categorised this site as having 'good' (spring and summer) health generically (Table 3). The historical median score (99 units) placed this site in the 'fair' category for generic health.

3.2.10.1.2 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 150m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 97 units. The summer score was significantly higher, while the spring score and historical median were not significantly higher than the predictive value (Stark, 1998).

3.2.10.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 99). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 15 years of SEM results (2003-2018) and the most recent ten-years of results (2008-2018) from the site in the Waiokura Stream at the site on Skeet Road.



N = 27
Kendall tau = +0.496
p level <0.001
FDR p < 0.001

N = 20
Kendall tau = +0.269
p level = 0.097
FDR p = 0.46

Figure 99 LOWESS trend plot of MCI data in the Waiokura Stream at the Skeet Road site for the full dataset with Mann-Kendall test for the full and ten-year dataset

This site shows a statisitically significant positive trend (FDR $p < 0.01$). Since 2009, there has been relatively strong temporal improvement in MCI scores at this site, with a minor decrease since 2014. The trendline range of MCI scores (11 units) has bordered on ecological importance. Increases in scores may have been related to improvements in farming practices and/or wastes disposal in the rural catchment between the stream's seepage sources (below the National Park) and mid reaches at Skeet Road, although the shorter duration and less frequent initial monitoring must be noted.

Trendline MCI scores have been indicative of 'fair' generic stream health for the first eight years of the period improving to the 'good' health category over the most recent seven years.

The ten-year period shows a positive trend, congruent with the full dataset, however this trend was not statistically significant.

3.2.10.2 Manaia golf course site (WKR000700)

3.2.10.2.1 Taxa richness and MCI

Twenty surveys have been undertaken at this more recently established lower reach site in the Waiokura Stream at Manaia between 2007 and February 2017. These results are summarised in Table 54 together with the results from the current period, and illustrated in Figure 100.

Table 54 Results of previous surveys performed at Waiokura Stream at Manaia golf course, together with 2017-2018 results

Site code	SEM data (2007 to Febuary 2017)						2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000700	20	16-27	23	92-109	98	17	105	17	104

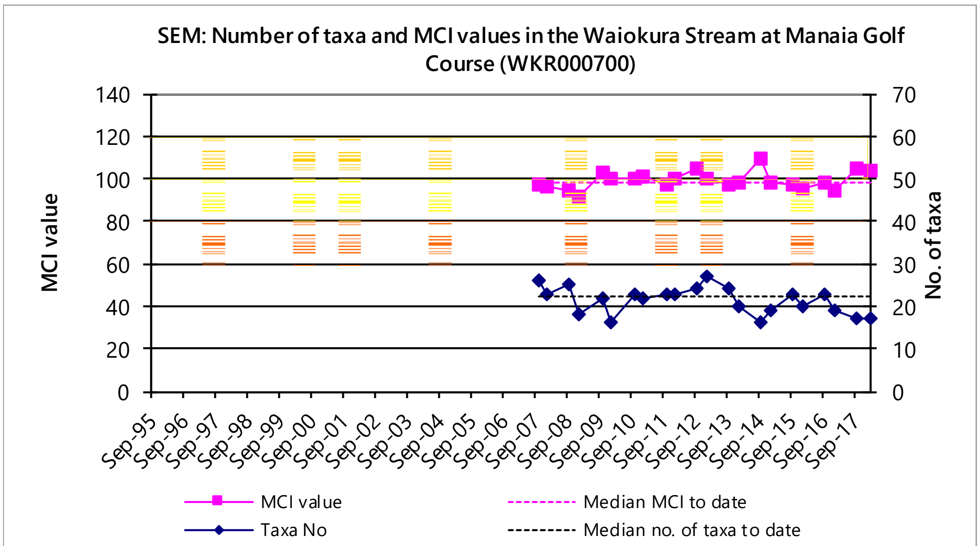


Figure 100 Numbers of taxa and MCI values in the Waiokura Stream at Manaia Golf course

A moderate range of richness (16 to 27 taxa) has been found, with a median richness of 23 taxa (more representative of typical richness for the lower reaches of ringplain streams rising outside the National Park boundary). During the 2017-2018 period spring (17 taxa) and summer (17 taxa) richness were the same but six taxa few than the median richness.

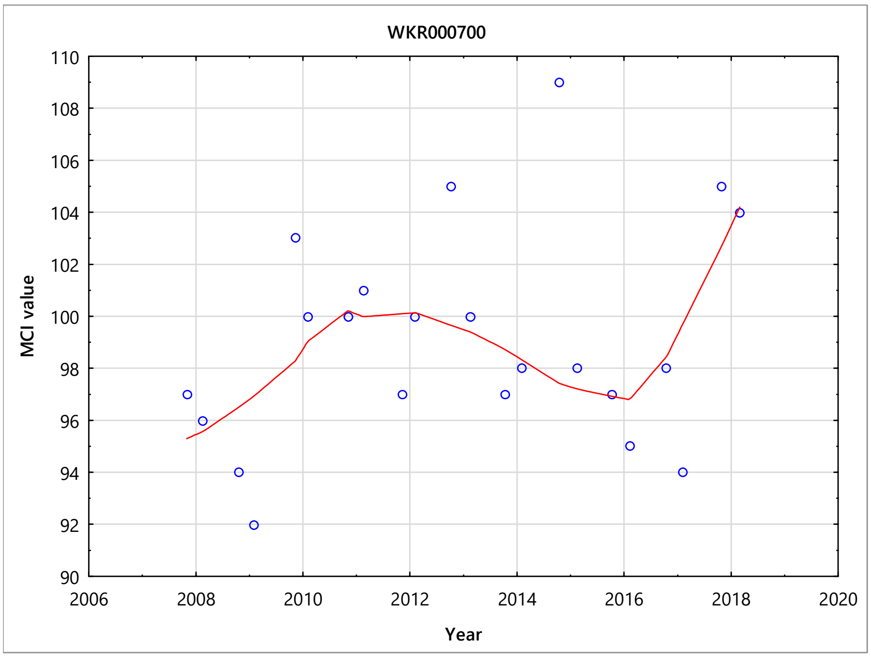
MCI values have had a narrow range (17 units) at this site partly due to the short duration of the monitoring period to date. The median value (98 units) has been slightly higher than typical of similar lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (105 units) and summer 2018 (104 units) scores were not significantly different to the historical median score. These scores categorised this site as having 'good' (spring and summer) health generically (Table 3). The historical median score (98 units) placed this site in the 'fair' category for generic health.

3.2.10.2.2 Predicted stream 'health'

The Waiokura Stream rises below the National Park boundary and the site at the Manaia golf course is in the lower reaches at an altitude of 70 m asl. The REC predicted MCI value for this site (Leathwick, et al. 2009) was 95 units. The historical median, spring and summer scores were not significantly different from the REC predictive value.

3.2.10.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 101). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the full 11 years of SEM data (2007-2018) and the most recent ten-years of SEM results (2008-2018) from the site in the Waiokura Stream at Manaia golf course.



N = 22
Kendall tau = +0.117
p level =0.446
FDR p = 0.55

N = 20
Kendall tau = +0.033
p level =0.840
FDR p = 0.87

Figure 101 LOWESS trend plot of MCI data in the Waiokura Stream for the Manaia golf course for the full dataset with Mann-Kendall test for the full and ten-year dataset

A positive, non-significant trend of improvement in MCI scores since 2009 to that found at the upstream site (at Skeet Road) was identified at this site at the Manaia golf course (although more stable since 2010). The relatively narrow range of scores (nine units) has no ecological importance to date.

The trendline range indicated 'fair' generic stream health for two years of the monitoring period, improved to 'good' stream health for about three years before returning to 'fair' stream health most recently.

The ten-year period had a positive trend. As with the full dataset, this was neither statistically or ecologically significant.

3.2.10.3 Discussion

Taxa richness for both surveys were moderate at both sites and within previous recorded ranges.

The spring survey indicated that the macroinvertebrate community at both sites were in 'good' health and in typical condition. The summer survey indicated that both macroinvertebrate communities were in 'good' health and in better than typical condition at the upper site, while the lower site was similar to normal. The MCI score increased by three units in spring and decreased by six units in summer in a downstream direction over the 9.7 km reach, between the more open farmland mid-reach site (Skeet Road) and the lower reach Manaia golf course site. This was despite some improvement in habitat provided by patches of riparian vegetation cover through the golf course.

The time trend analysis indicated a significant positive trend after FDR adjustment at the upper site over the full period. In contrast, the lower site had a weak positive trend. This result may be influenced by the shorter monitoring period at the lower site. There were no significant trends at either site over the most recent ten-year period.

3.2.11 Waiongana Stream

The Waiongana Stream has a source within Egmont National Park and flows in an easterly direction with a mouth just east of Bell Block. There are two sites on the stream used for SEM surveys. The results for the 2017-2018 survey sare presented in Table 109 and Table 110, Appendix I.

3.2.11.1 State Highway 3a site (WGA000260)

3.2.11.1.1 Taxa richness and MCI

Forty-three surveys have been undertaken at this mid reach site in the Waiongana Stream between October 1995 and February 2017. These results are summarised in Table 55, together with the results from the current period, and illustrated in Figure 102.

Table 55 Results of previous surveys performed in the Waiongana Stream at SH3A together with the 2017-2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGA000260	43	9-30	24	82-112	97	20	102	31	94

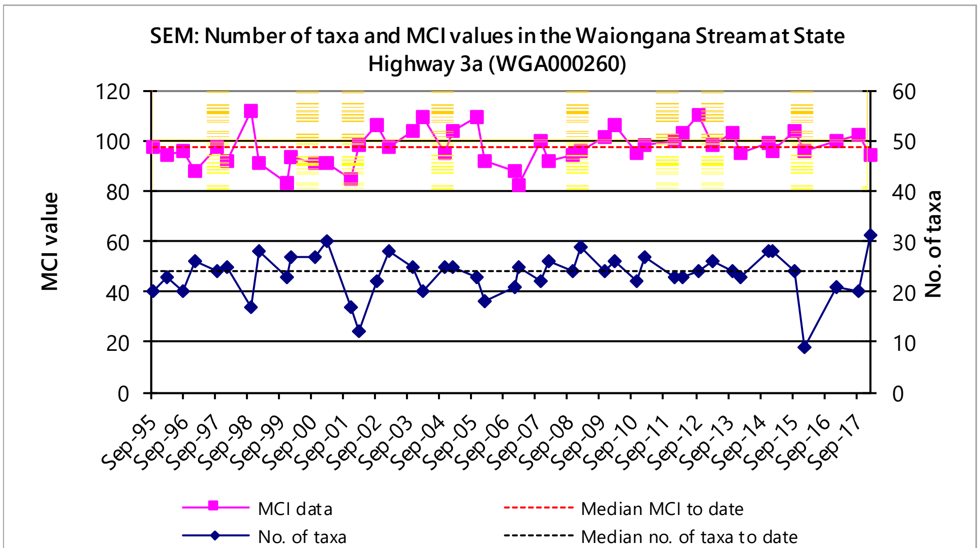


Figure 102 Numbers of taxa and MCI values in the Waiongana Stream at State Highway 3A

A wide range of richness (9 to 30 taxa) has been found; with a median richness of 24 taxa (more representative of typical richness in the mid-reaches of ringplain streams and rivers. During the 2017-2018 period, the spring (20 taxa) richness was similar to the historical median, while the summer (31 taxa) richness was a substantial seven taxa higher than the median, and was the highest richness recorded at this site to date.

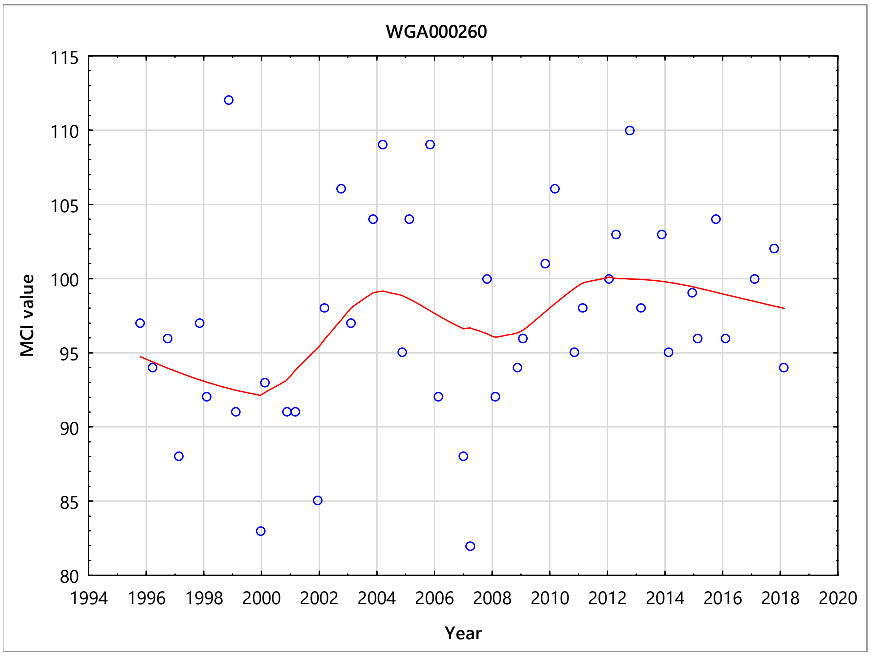
MCI values have also had a relatively wide range (30 units) at this site, relatively typical of a site in the mid reaches of a ringplain stream. The median value (97 units) also has been typical of mid-reach sites elsewhere on the ringplain (TRC, 2017b). The summer 2017 (94 units) survey was not significantly different to the historical median. The score categorised this site as having 'fair' (summer) health generically (Table 3). The historical median score (97 units) placed this site in the 'fair' category.

3.2.11.1.2 Predicted stream 'health'

The Waiongana Stream site at SH3a is 16.1 km downstream of the National Park boundary at an altitude of 140 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 100 for this site. The historical site median (97 units), spring (102) and summer scores (94 units) were not significantly different from this value. The REC predicted MCI val units) ue (Leathwick, et al. 2009) was 99 units. The historical site median, srping and summer scores were also not significantly different to this value.

3.2.11.1.3 Temporal trends in 1995 to 2018 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 103). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waiongana Stream at SH3A.



N = 45
Kendall tau = 0.206
p level = 0.046
FDR p = 0.090

N = 19
Kendall tau = 0.030
p level = 0.858
FDR p = 0.870

Figure 103 LOWESS trend plot of MCI data at the SH3A site

There has been a non-significant positive trend in the MCI scores with a steady improvement in scores between 2001 and 2004 followed by a decline in scores until 2008, and another steady increase until 2012 where subsequently another gradual decline is evident. This site's trendline had a range of eight units indicative of marginal ecologically important variability over the period. Overall, the trendline was indicative of ‘fair’ generic stream health for the majority of the period, improving toward ‘good’ ‘health’ briefly in 2011 and 2012.

There was a non-significant positive trend in MCI scores over the most recent ten-year period, congruent with the full dataset, with a decline in the trendline from 2012 onwards. The trendline for the most recent ten-year period was indicative of ‘fair’ health.

3.2.11.2 Devon Road site (WGA000450)

3.2.11.2.1 Taxa richness and MCI

Forty-four surveys have been undertaken at this lower reach site at SH45 in the Waiongana Stream between October 1995 and February 2017. These results are summarised in Table 56, together with the results from the current period, and illustrated in Figure 104.

Table 56 Results of previous surveys performed in the Waiongana Stream at Devon Road together with spring 2017 and summer 2018 results

Site code	SEM data (1995 to February 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGA000450	44	12-29	22	72-102	90	18	86	20	87

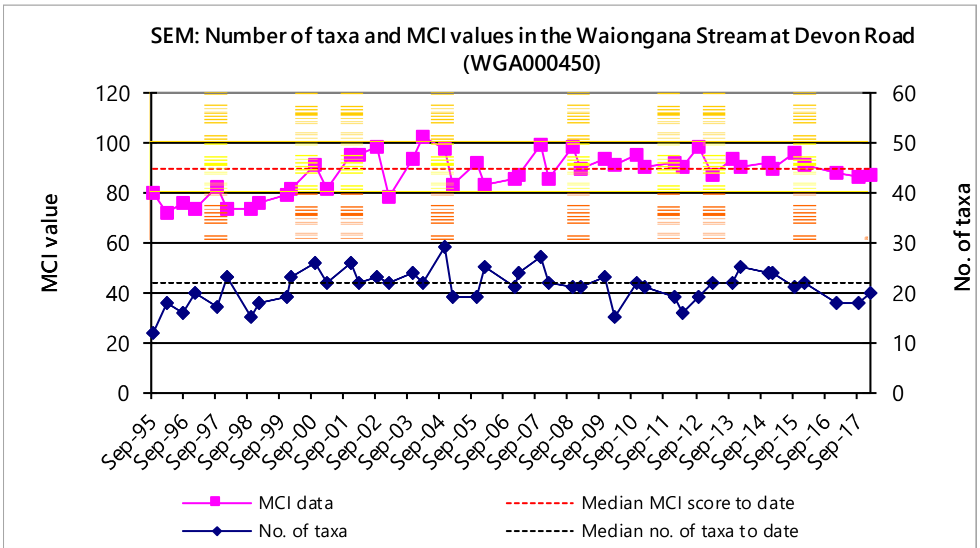


Figure 104 Numbers of taxa and MCI values in the Waiongana Stream at Devon Road

A wide range of richness (12 to 29 taxa) has been found with a median richness of 22 taxa, more representative of typical richness in ringplain streams and rivers in the lower reaches. During the 2017-2018 period, spring (18 taxa) richness was typical and summer (20 taxa) richneses were similar to the historic median.

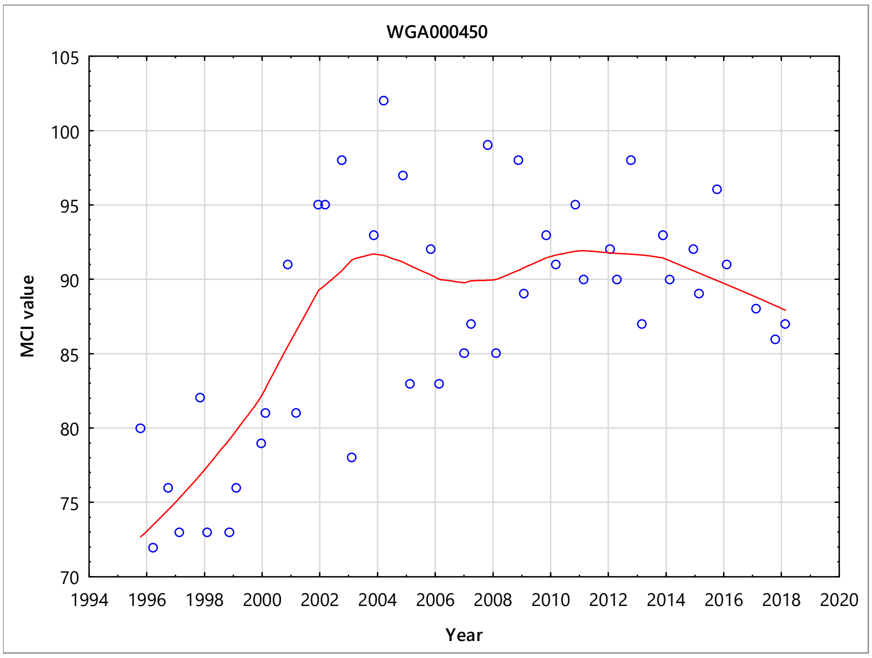
MCI scores have had a relatively wide range (30 units) at this site typical of sites in the lower reaches of ringplain streams. The median value (90 units) also has been typical of lower reach sites elsewhere on the ringplain (TRC, 2017b), with the spring 2017 (86 units) and summer 2018 (87 units) scores were typical for the site. These scores categorized this site as having ‘fair’ (spring and summer) health (Table 3). The historical median score (90 units) placed this site in the ‘fair’ category for generic health.

3.2.11.2.2 Predicted stream 'health'

The Waiongana Stream at Devon Road is 31.2 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 93 for this site. The historical site median, spring and summer scores were not significantly different from this value. The REC predicted MCI value (Leathwick, et al. 2009) was 88 units. The historical site median, spring and summer scores were also not significantly different to this value.

3.2.11.2.3 Temporal trends in 1995 to 2018 data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 105). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waiongana Stream at Devon Road.



N = 45
Kendall tau = 0.319
p level = 0.002
FDR p = 0.010

N = 19
Kendall tau = -0.348
p level = 0.037
FDR p = 0.360

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

MCI scores at this site have shown a statistically significant (FDR p =0.01) improvement over the period, despite little change since 2003. The trendline has varied over an ecologically important range of 19 units. Improvement has been coincident with a reduction in consented NPDC water abstraction and tighter control of an upstream piggery's waste loadings into the stream. This trend of improvement in stream 'health' at this site is much more pronounced than the trend at the site some 15 km upstream, indicating that activities in the catchment between these two sites have had a significant influence on the bottom site. Overall, the trendline has indicated significant improvement in generic stream 'health' from consistently 'poor' prior to 2000 to 'fair' where it has remained over the last 17 years.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, in contrast with the full dataset with a decline in the trendline from 2011 onwards. There was a significant decline prior to FDR application. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.11.3 Discussion

Taxa richness for both sites increased from spring to summer. The surveys indicated that the mid-reach (SH3a) site was in 'good' to 'fair' health while the lower reach (Devon Road) was in 'fair' health. MCI scores typically decreased in a downstream for both spring (a significant 16 units) and summer surveys, over a stream distance of 15.1 km downstream from the National Park boundary. The decrease in score was proably attributable to diffuse and point source discharges that have caused nutrient enrichment.

The time trend analysis indicated a significant positive trend after FDR adjustment at the lower site over the entire montirong period but interestingly there was a significant negative trend for the site prior to FDR adjustment over the most recent 10-year period indicating a more recent decline in macroinvertebrate health.

3.2.12 Waitara River

The Waitara River is Taranaki's largest river with significant catchment areas in both the eastern hill country and on the eastern side of the Taranaki ringplain. Two SEM sites are situated on the mainstem of the Waitara River. Results found by the 2017-2018 surveys are presented in Table 111 and Table 112, Appendix I.

3.2.12.1 Autawa Road site (WTR000540)

3.2.12.1.1 Taxa richness and MCI

This is the third set of surveys at this recently established middle reach site in the Waitara River where surveys have been carried out between October 2015 and March 2017. These results are summarised in Table 57 and illustrated in Figure 106.

Table 57 Results of the spring 2017-2018 surveys performed in the Waitara River at Autawa Road

Site code	SEM data (2015 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WTR000540	4	19-26	26	95-102	99	21	110	19	97

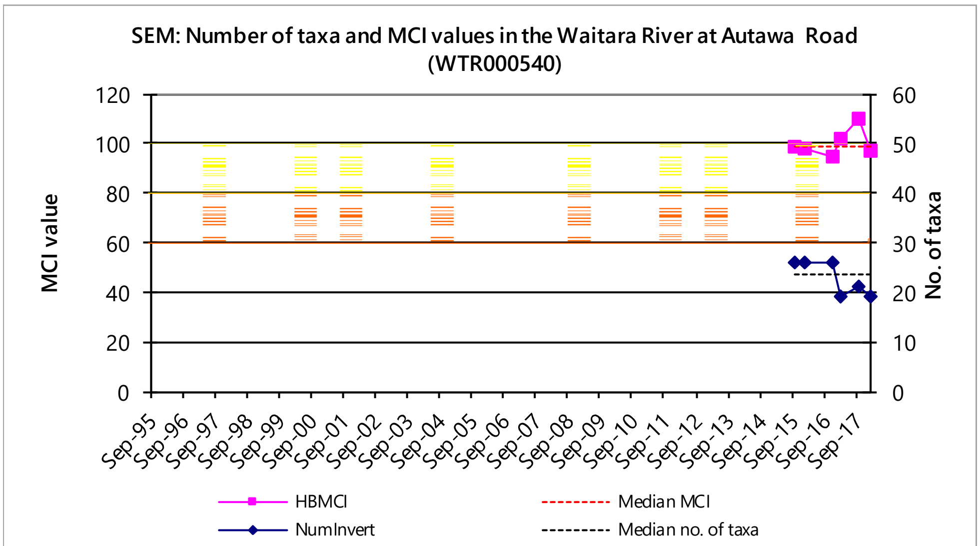


Figure 106 Numbers of taxa and MCI values in the Waitara River at Autawa Road

Slight variation in taxa richness (seven taxa) has been found with a median richness of 26 taxa. A moderate richness of 21 taxa was recorded for the spring survey with a lower but still moderate taxa richness of 19 taxa recorded for the summer survey.

MCI values have had a narrow range (seven MCI units) at this site suggesting little seasonal variation. The median value (99 units) was slightly higher than typical lower reach sites elsewhere although lower reach sites in large hill country rivers tended to have had lower MCI values (TRC, 2017b). The spring 2017 score (110 units) was significantly higher than the median score and was the highest score recorded to date at this site, while the summer 2018 score (97 units) was not significantly different from the historical median. These scores categorised this site as having 'good' health generically (Table 3) in spring and 'fair' health in summer.

3.2.12.1.2 Predicted stream 'health'

The Waitara River site at Autawa Road, at an altitude of 100 m asl, is in the middle reaches the river draining a catchment comprised of eastern hill country. The REC predicted MCI value (Leathwick, et al. 2009) was 110 units. The historical median and summer score, were significantly lower than this value. The spring score was equal to this value.

3.2.12.1.3 Temporal trends

There is insufficient data to perform a time trend analysis for the site.

3.2.12.2 Mamaku Road site (WTR000850)

3.2.12.2.1 Taxa richness and MCI

Forty-three surveys have been undertaken at this lower reach site in the Waitara River between November 1995 and March 2017. These results are summarised in Table 58, together with the results from the current period, and illustrated in Figure 107.

Table 58 Results of previous surveys performed in the Waitara River at Mamaku Road together with spring 2017-2018 results

Site code	SEM data (1995 to March 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WTR000850	43	9-32	18	64-107	86	8	83	11	64

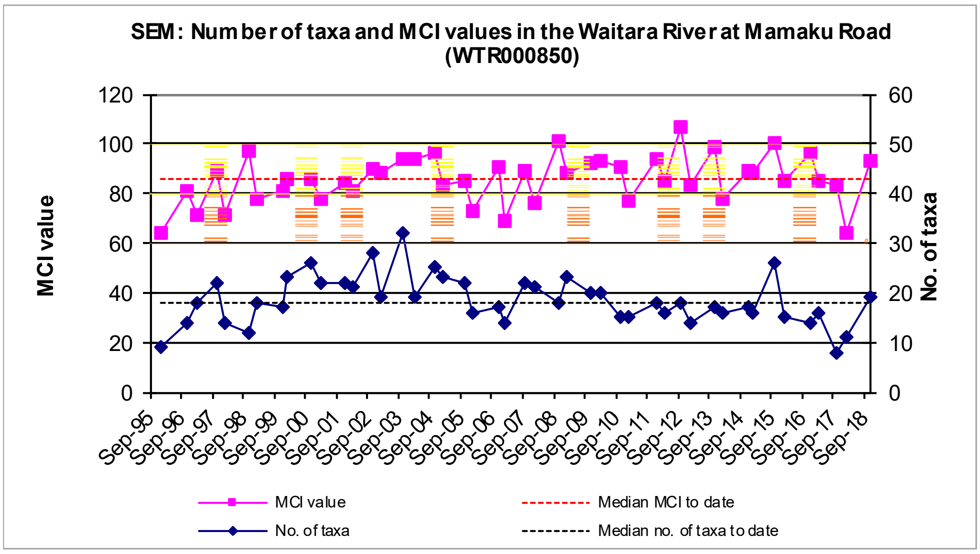


Figure 107 Numbers of taxa and MCI values in the Waitara River upstream of Methanex at Mamaku Road

A very wide range of richness (9 to 32 taxa) has been found with a moderate median richness of 18 taxa (more representative of typical richness in the lower reaches of streams and rivers (TRC, 2017b)). During the 2017-2018 period, spring and summer richness (8 and 11 taxa respectively) were lower than this median richness, with the spring richness being the lowest richness recorded at this site to date.

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, 2017b). The spring 2017 (83 units) score was not significantly different to the historical median, while the summer 2018 (64 units) score was significantly lower than this historical median and was equal to the lowest MCI score recorded at this site to date (Stark, 1998). These scores categorised this site as having ‘fair’ (spring) and ‘poor’ (summer) health generically (Table 3). The historical median score (86 units) placed this site in the ‘fair’ category.

3.2.12.2.2 Predicted stream ‘health’

The Waitara River site at Mamaku Road, at an altitude of 15 m asl, is in the lower reaches of a river draining a catchment comprised of both hill country and ringplain sub-catchments. The REC predicted MCI value (Leathwick, et al. 2009) was 98 units. The historical site median, spring and summer scores were significantly lower than this value (by 12, 15 and 34 units respectively).

3.2.12.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 108). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1996-2018) and the most recent ten-years of results (2008-2018) from the site in the Waitara River at Mamaku Road.

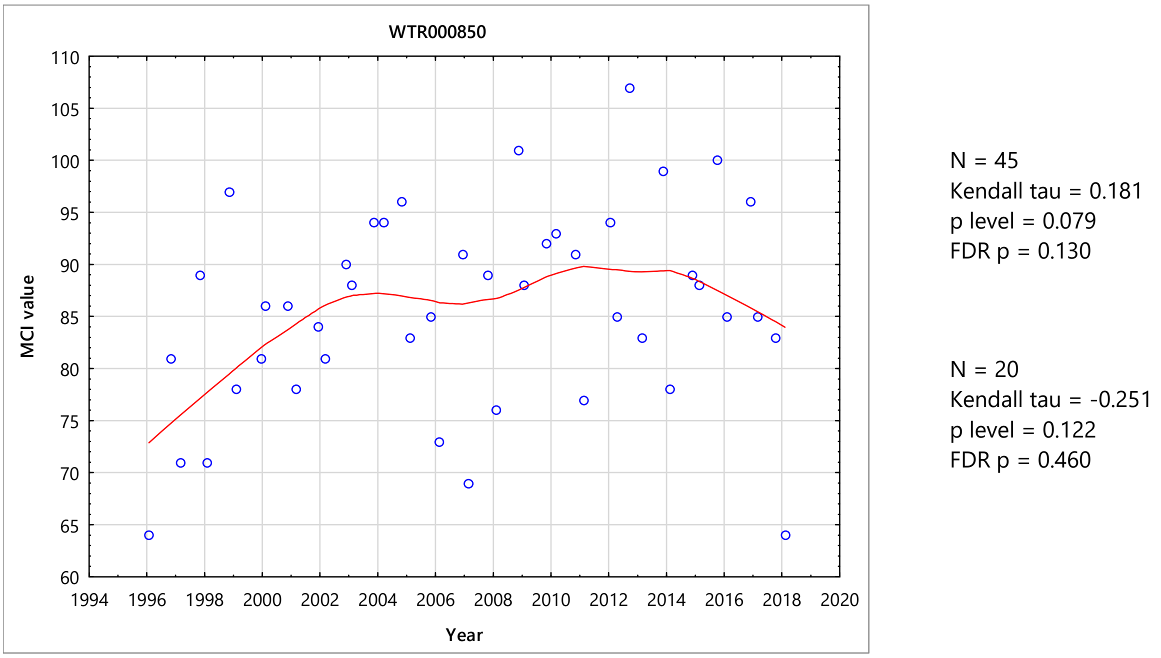


Figure 108 LOWESS trend plot of MCI data for the Mamaku Road site, Waitara River

There was a non-significant positive trend for the 22-year period. The trendline range (17 units) has been ecologically important over the period. The trendline has been indicative of a general improvement from ‘poor’ (in the first few years) to ‘fair’ generic river health.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, in contrast with the full dataset, with a decline in the trendline from 2011 onwards. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.12.3 Discussion

Taxa richness for the upper site was moderate but the lower site had unusally low richness for both spring and summer surveys. The spring survey richness of eight taxa was the lowest recorded taxa richness to date while the taxa richness of 11 taxa for the summer survey was the third lowest richness to date.

Coincident with the low summer taxa richness, but not the lower spring taxa richness, was the summer MCI score which was the equal lowest recorded to date for the site and indicated 'poor' health. There is no obvious reason for the low taxa richness or summer MCI score. The upper site in contrast had a new record high MCI score for spring and a typical summer score indicating 'good' to 'fair' health. There were large downstream deterioations in macroinvertebrate health, 46 MCI units in spring and 33 MCI units in summer. The decrease in score was proably attributable to diffuse and point source discharges that have caused nutrient enrichment though the low taxa richness at the bottom site could indicate some sort of toxic discharge negatively affecting the macroinvertebrate community there.

The time trend analysis found no significant trends over the full or ten-year datasets and it appears that there has been no significant change in macroinvertebrate community health.

3.2.13 Waiwhakaiho River

The Waiwhakaiho River has a source inside Egmont National Park and flows in an easterly direction with its mouth situated in the city of New Plymouth. An additional site was established in the upper reaches of the Waiwhakaiho River for the 2002-2003 SEM programme, to complement the three sites in the central to lower reaches of this large ringplain river, in recognition of its importance as a water resource and particularly its proximity to New Plymouth city. The site was established a short distance inside the National Park boundary at an elevation of 460 m asl. The results from the 2017-2018 surveys are presented in Table 113 and Table 114, Appendix I.

3.2.13.1 National Park site (WKH000100)

3.2.13.1.1 Taxa richness and MCI

Twenty-nine 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 2017. These results are summarised in Table 59, together with the result from the current period, and illustrated in Figure 109.

Table 59 Results of previous surveys performed in the Waiwhakaiho River at National Park together with the 2017-2018 results

Site code	SEM data (2002 to Febuary 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000100	29	4-29	19	115-147	130	17	131	18	132

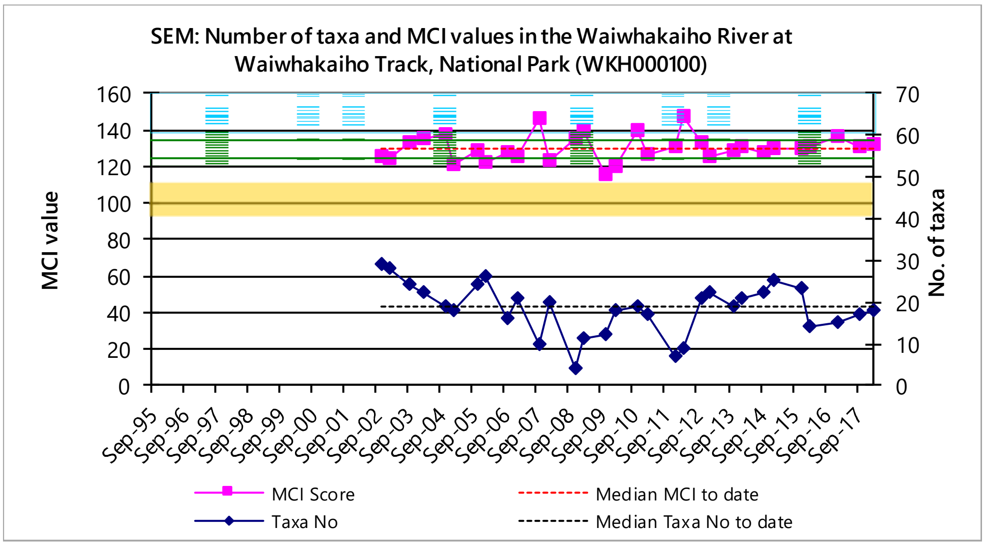


Figure 109 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont National Park

A wide range of richness (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 richness [e.g. median of 28 taxa and maximum of 40 taxa] in ringplain streams and rivers near the National Park boundary (TRC, 2017b). During the 2017-2018 period spring (17 taxa) and summer (18 taxa) richness were similar to the median richness.

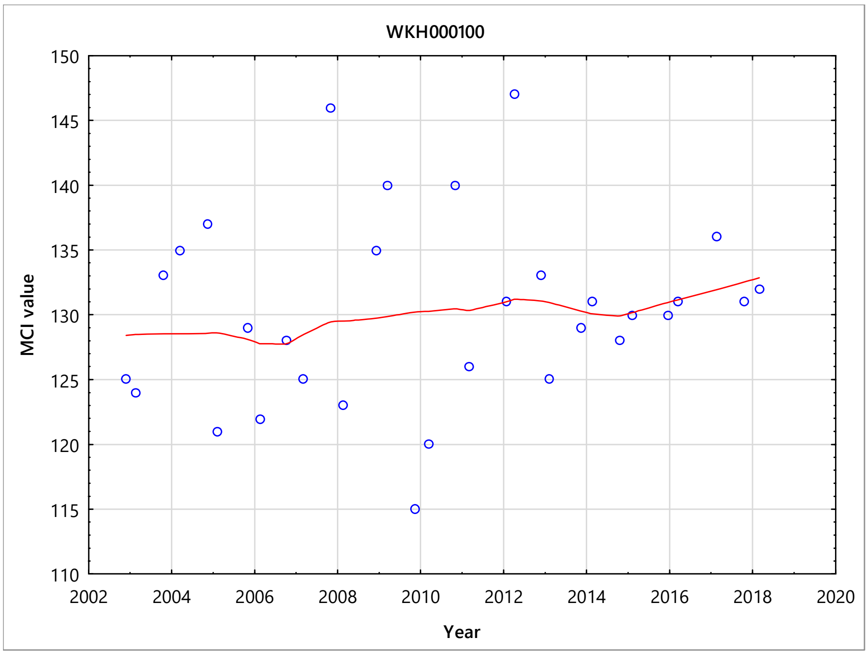
MCI values have had a wider range (32 units) at this site than typical of a National Park boundary site, due in part to an atypically very high value in 2008 following a marked drop in richness and low values after the 2008-2009 headwater erosion period. The spring 2017 (131 units) and summer 2018 (132 units) scores were not significantly different to the historical median and categorised this site as having 'very good' (spring and summer) health generically. The historical median score (130 units) placed this site in the 'very good' category for health.

3.2.13.1.2 Predicted stream 'health'

The Waiwhakaiho River site at the National Park is just inside the National Park boundary at an altitude of 460 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median (130 units), spring (131 units) and summer survey (132) scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 137 units. Again, the historical site median, spring and summer scores were not significantly different to this value.

3.2.13.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 110). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 15 years of SEM results (2002-2018) and the most recent ten-years of results (2008-2018) from the site in the Waiwhakaiho River at the National Park.



N = 31
Kendall tau = 0.157
p level = 0.214
FDR p = 0.280

N = 19
Kendall tau = 0.090
p level = 0.591
FDR p = 0.750

Figure 110 LOWESS trend plot of MCI data at the National Park site

No significant temporal trend in MCI scores has been found over the 15-year monitoring period at this site within the National Park. The trendline has a range of only six units have consistently indicated 'very good' generic river health over the period.

There was a non-significant postive trend in MCI scores over the most recent ten-year period, congruent with the full dataset. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.13.2 Egmont Village site (WKH000500)

3.2.13.2.1 Taxa richness and MCI

Forty-three 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 2017. These results are summarised in Table 60, together with the results from the current period, and illustrated in Figure 111.

Table 60 Results of previous surveys performed in the Waiwhakaiho River at Egmont Village together with the 2017-2018 results

Site code	SEM data (1995 to Febuary 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000500	43	14-32	23	87-125	111	17	114	19	98

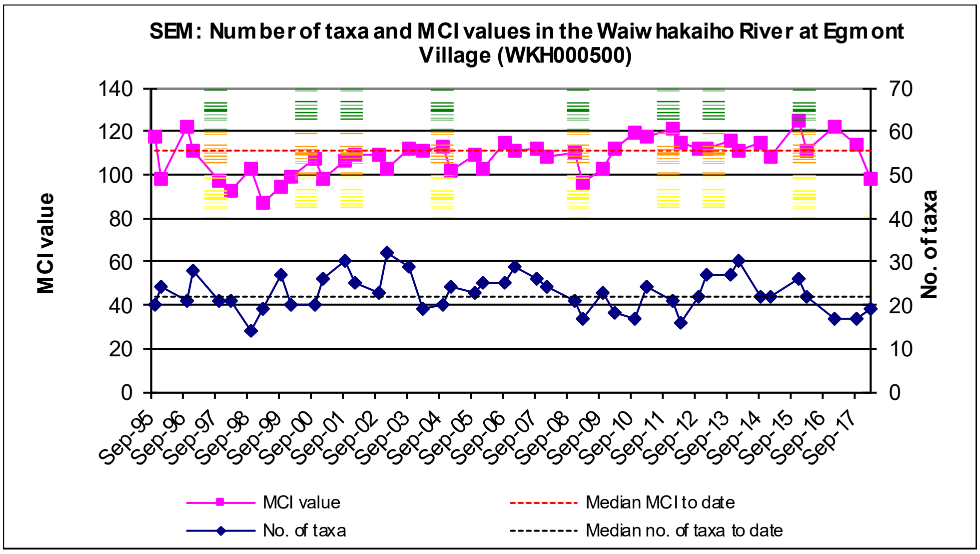


Figure 111 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont Village

A wide range of richness (14 to 32 taxa) has been found; wider than might be expected, with a median richness of 23 taxa (more representative of typical richness in the mid reaches of ringplain streams and rivers (TRC, 2017b)). During the 2017-2018 period the spring (17 taxa) and summer (19 taxa) surveys had moderate richness and was up to six taxa lower than the median taxa number.

MCI values have had a slightly wider range (388 units) at this site than typical of sites in the mid reaches of ringplain rivers but the median value (111 units) has been relatively typical of mid reach sites elsewhere on the ringplain. The spring 2017 (114 units) score was similar to the historical median, while the summer 2018 (98 units) score was significantly lower than the historical median. The scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically. The historical median score (110 units) placed this site in the 'good' category for generic health.

3.2.13.2.2 Predicted stream 'health'

The Waiwhakaiho River site at Egmont Village is 10.6 km downstream of the National Park boundary at an altitude of 175 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 105 for this site. The historical site median (111), spring (114 units) and summer (98) scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 115 units. The historical site median and spring score were not significantly different to this value but the summer score was significantly lower.

3.2.13.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 112). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waiwhakaiho River at Egmont Village.

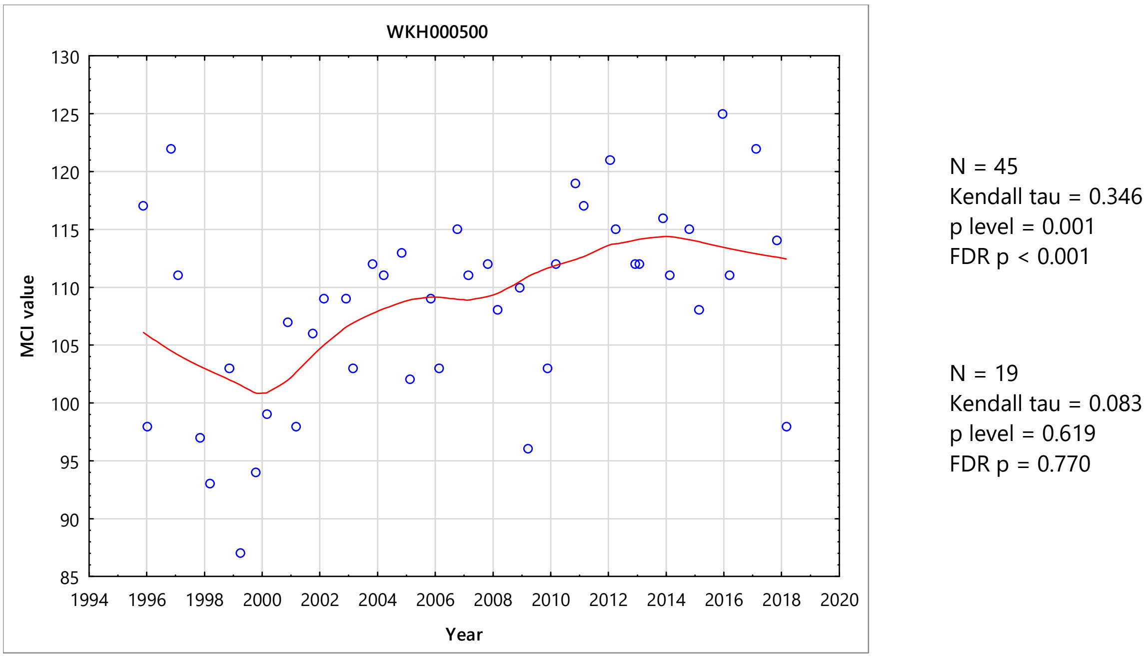


Figure 112 LOWESS trend plot of MCI data at the Egmont Village site

A highly significant positive trend in MCI scores (FDR $p < 0.01$) has been found during the 23-year period indicating an overall improvement in macroinvertebrate health at the site. After some initial deterioration in scores, there has been a steady improvement since 1999. While the individual scores were indicative of 'good' to 'fair' generic river health over the first five years, the trendline had a range of 13 units which indicated that macroinvertebrate health has consistently remained 'good'.

There was a non-significant postive trend in MCI scores over the most recent ten-year period with a slight decline in the trendline evident from 2014 onwards. The trendline for the most recent ten-year period was indicative of 'good' health.

3.2.13.3 Constance Street site (WKH000920)

3.2.13.3.1 Taxa richness and MCI

Forty-four 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 2017. These results are summarised in Table 61, together with the results from the current period, and illustrated in Figure 113.

Table 61 Results of previous surveys performed in the Waiwhakaiho River at Constance Street, New Plymouth, together with 2017-2018 results

Site code	SEM data (1995 to Febuary 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000920	44	12-29	20	71-110	94	16	106	13	71

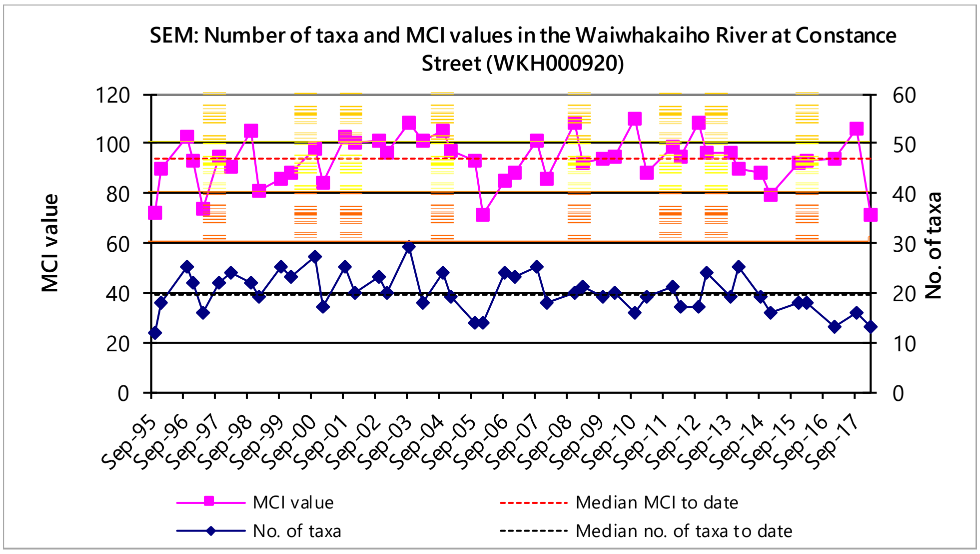


Figure 113 Numbers of taxa and MCI values in the Waiwhakaiho River at Constance Street

A wide range of richness (12 to 29 taxa) has been found with a median richness of 20 taxa (more representative of typical richness in the lower reaches of ringplain streams and rivers (TRC, 2017b)). During the 2017-2018 period, spring (16 taxa) and summer (13 taxa) richness were four and seven taxa lower than the median richness respectively.

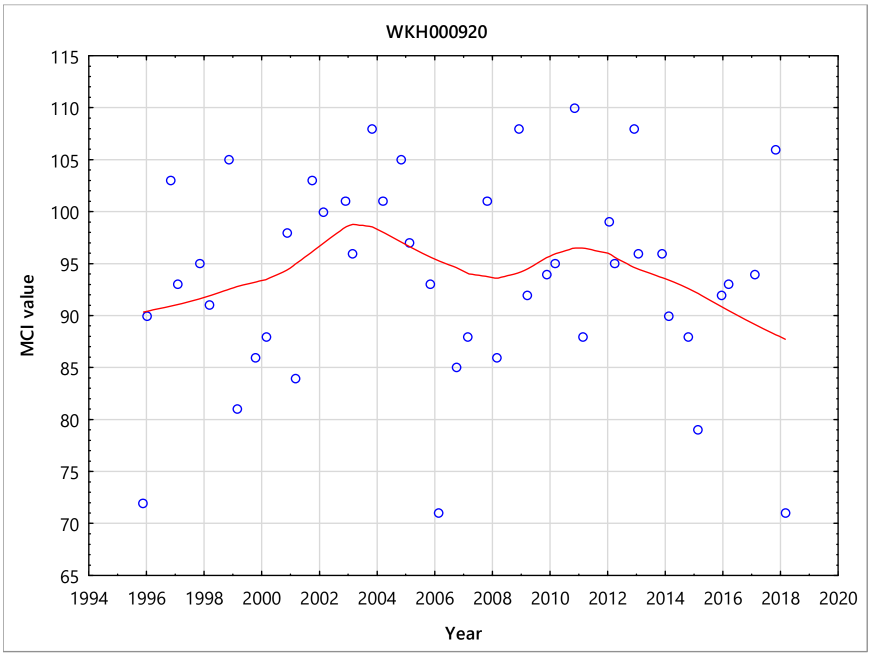
MCI values have had a wide range (39 units) at this site. The median value (94 units) has been relatively typical of scores at lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (106 units) score was significantly higher than the historical median, while the summer 2018 (71 units) score was significantly lower than the historical median and was equal to the lowest score recorded at this site to date. There was a large decrease of 33 units between spring and summer, suggesting a rapid deterioattion in water quality between the two sampling dates. The MCI scores categorised this site as having 'good' (spring) and 'poor' (summer) health generically (Table 3). The historical median score (94 units) placed this site in the 'fair' category.

3.2.13.3.2 Predicted stream 'health'

The Waiwhakaiho River site at Constance Street, New Plymouth is 26.6 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 95 for this site. The historical site median (94) was not significantly different to the distance predictive value (Stark, 1998), while the spring score was signifcantly higher and the summer score was significantly lower. The REC predicted MCI value (Leathwick, et al. 2009) was 97 units. The historical site median and spring scores were not significantly different to this value, while the summer score was signifcnatly lower.

3.2.13.3.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 114). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1995-2018) and the most recent ten-years of results (2008-2018) from the site in the Waiwhakaiho River at Constance Street.



N = 45
Kendall tau = 0.004
p level = 0.968
FDR p = 0.970

N = 19
Kendall tau = -0.244
p level = 0.144
FDR p = 0.460

Figure 114 LOWESS trend plot of MCI data at the Constance Street site

The overall trend in MCI scores has not been statistically significant for the period, due mainly to some decline and subsequent recovery in scores after 2005 and again since 2012. The trendline had a range of 11 units which indicates variability of some ecological importance. The trendline range indicated 'fair' generic river health for the entire period. The trend line was improving toward 'good' health (after a small increase in summer residual flow releases by the TrustPower Mangorei HEP scheme) from 1995-2003 but subsequently decreased with no overall improvement in health over the monitored period.

In constrast to the full dataset there was a non-significant negative trend in MCI scores over the most recent ten-year period with a decline in the trendline evident from 2011 onwards. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.13.4 Site adjacent to Lake Rotomanu (WKH000950)

3.2.13.4.1 Taxa richness and MCI

Forty-one surveys have been undertaken in the Waiwhakaiho River at this lower reach site adjacent to Lake Rotomanu between November 1996 and February 2017. These results are summarised in Table 62, together with the results from the current period, and illustrated in Figure 115.

Table 62 Results of previous surveys performed in the Waiwhakaiho River the site adjacent to Lake Rotomanu, together with the 2017-2018 results

Site code	SEM data (1996 to Febuary 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Mar 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000950	41	12-30	21	70-111	89	16	101	17	85

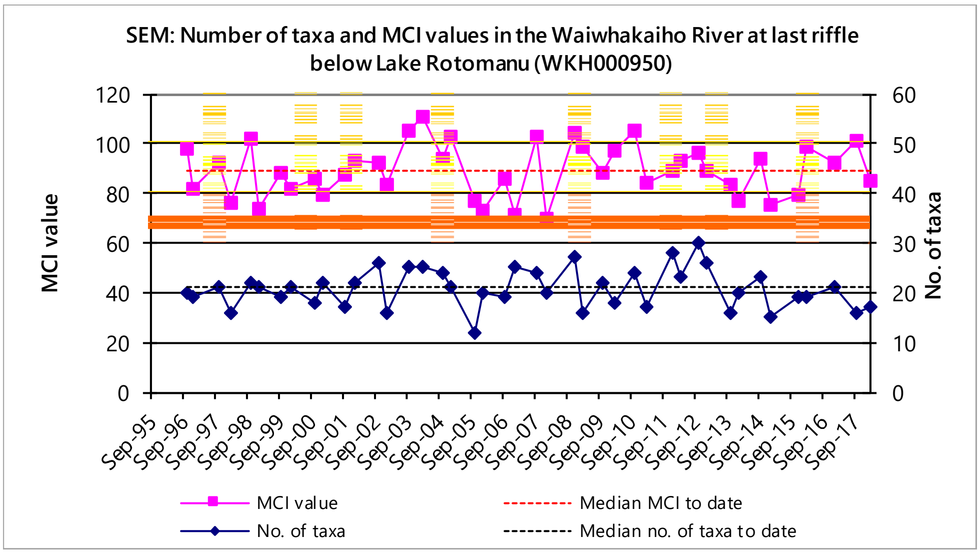


Figure 115 Numbers of taxa and MCI values in the Waiwhakaiho River at Lake Rotomanu

A wide range of richness (12 to 30 taxa) has been found; wider than might be expected, with a median richness of 21 taxa. During the 2017-2018 period spring (16 taxa) and summer (17 taxa) richness were lower than the historical median richness.

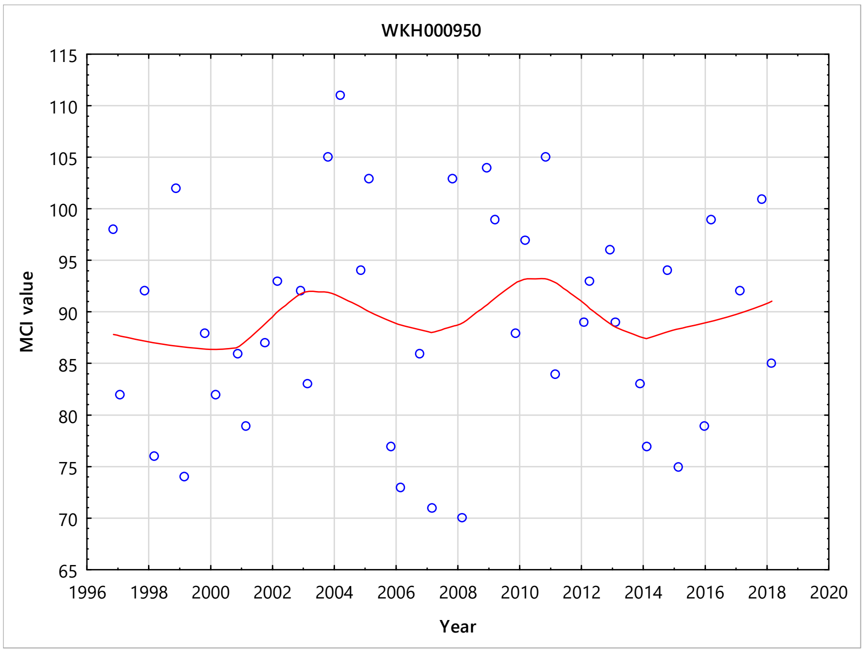
MCI values have had a wide range (41 units) at this site but typical of variable scores at sites in the lower reaches of ringplain streams. The median value (89 units) has been relatively typical of lower reach sites elsewhere on the ringplain (TRC, 2017b). The spring 2017 (101 units) score was significantly higher than the historical median, while the summer 2018 (85 units) scorewas not significantly different from the historical median (Stark, 1998). The scores categorised this site as having 'good (spring) and 'fair' (summer) health generically. The historical median score (89 units) placed this site in the 'fair' generic health category (Table 3).

3.2.13.4.2 Predicted stream 'health'

The Waiwhakaiho River at the site adjacent to Lake Rotomanu is 28.4 km downstream of the National Park boundary at an altitude of 2 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 94 for this site. The historical site median, spring and summer survey scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 97 units. The historical site median and spring scores were also not significantly different to this value, while the summer score was significantly lower.

3.2.13.4.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 116). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 22 years of SEM results (1996-2018) and the most recent ten-years of results (2008-2018) from the site in the Waiwhakaiho River adjacent to Lake Rotomanu.



N = 43
Kendall tau = 0.042
p level = 0.688
FDR, p = 0.788

N = 19
Kendall tau = -0.229
p level = 0.170
FDR, p = 0.460

Figure 116 LOWESS trend plot of MCI data at the site adjacent to Lake Rotomanu

Overall, MCI scores have shown no statistically significant trend. There was an improvement from 1995 to 2003 but since 2004, there has been a steady decline in scores toward scores typically found in the first two years of the programme followed by another improvement and subsequent decline, relatively similar trends to those found at the nearest upstream site (Constance St). The trendline covered a range of scores (eight units) of marginal ecological importance which showed slightly more variability over the 2007 to 2015 period. The trendline indicated 'fair' generic stream 'health' throughout the period.

In constrast to the full dataset there was a non-significant negative trend in MCI scores over the most recent ten-year period but no discernible general is evident. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.13.5 Discussion

Taxa richness were moderate to moderately low for the four sites. Richness were lower than usual ranging from one to eight taxa lower than historical.

The surveys indicated that the upper site had a macroinvertebrate community in 'very good' health while the site near Egmont Village had typical 'good' health during spring but only 'fair' health during summer, possibly due to the lower than normal flows that occurred over the summer. The two lowest sites also had significant decreases from spring to summer in MCI scores, more than what was typical with the second lowest site having a summer MCI score the equal lowest recorded to date. It indicated poor preceding water quality at the Constance St site between the spring and summer surveys, possibly due to some form of discharge into the river. The MCI score consistently decreased in a downstream direction with an overall decrease of a highly significant 31 MCI units in spring and 46 MCI units, over a river distance of 28.7 km, indicative of the poorer proceeding water quality at the lower sites.

The time trend analysis indicated a positive significant trend for Egmont Village for the full data set while no other significant trends occurred at other sites. The upper site was unlikely to change in condition as it is in a National Park while the two lower sites are in the city of New Plymouth and were subjected to urban and industrial sources of pollution as well as flucuationg flows from a hydro scheme. The site at Egmont Village has an upstream area dominated by agriculture and significant improvements in macroinvertebrate health at this site was likely due to improvements in the amount of point source and diffuse runoff emanating from farms.

3.2.14 Whenuakura River

The Whenuakura River has a catchment that is in eastern hill country with the lowest portion in the Taranaki sourthern marine terrace. It flows in a southeryly direction with a mouth between the townships of Patea and Waverly. One site in this river was included in the SEM programme in 2015 for the purpose of monitoring an additional site in the eastern hill country. The site is located in the lower reaches of the river at an altitude of approximately 20 m some ten km from the coast.

The results of the 2017–2018 spring and summer surveys are presented in Table 115, Appendix I.

3.2.14.1 Whenuakura River at Nicholson Road site (WNR000450)

3.2.14.1.1 Taxa richness and MCI

This is the third year of monitoring at this lower reach site in the Whenuakura River. These results from the current period are presented in Table 63, and illustrated in Figure 117.

Table 63 Results of previous surveys performed in the Whenuakura River at Nicholson Road, together with 2017-2018 results

Site code	SEM data (2015 to Febuary 2017)					2017-2018 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WNR000450	4	17-29	18	81-94	87	17	87	32	88

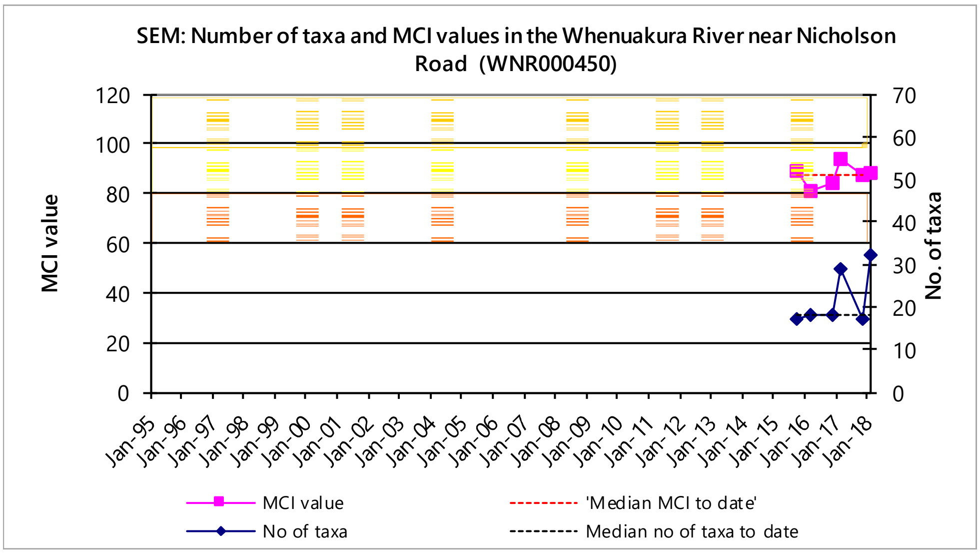


Figure 117 Numbers of taxa and MCI values in the Tangahoe River at Upper Tangahoe Valley Road

During the 2017-2018 period, spring (17 taxa) taxa richness was equal to the lowest recorded richness at this site to date, but despite this was very similar to the historical median and to three of the four prior surveys. The summer (32 taxa) richness was 14 taxa higher than the historical median and was the highest score recorded at this site to date.

MCI values have had a narrow range (13 units) at this site which was expected given only two surveys have been completed at the site. The historic median value (87 units) was slightly higher than was typical (78 units) of mid reach sites elsewhere as recorded at ‘control’ sites located at similar altitudes in hill country rivers and streams (TRC, 2017b). The spring 2017 (87 units) and summer 2018 (88 units) scores were not significantly different from each other and to the historical median. The scores categorised this site as having 'fair' health (spring and summer) generically. The historical median also classified this site as having 'fair' health (Table 3).

3.2.14.1.2 Predicted stream 'health'

The Whenuakura River at Nicholson Road, at an altitude of 20 m asl, is toward the lower reaches of this low gradient river draining an eastern hill country catchment. The REC predicted MCI value (Leathwick, et al. 2009) was 109 units and therefore the spring and summer scores were both significantly lower than this value (Stark, 1998).

3.2.14.1.3 Temporal trends in data

There was insufficient data to perform time trend analysis which requires a minimum of ten years data.

3.2.14.2 Discussion

Taxa richness was moderate during spring and high during summer (32 taxa and the highest score recorded to date) with a 15 taxa increase in summer, which was congruent with the previous survey that also found a large increase in taxa richness from spring to summer. This indicates that the site can have quite high taxa numbers despite being a soft bottom stream with high turbidity and that significant seasonal fluctuation in numbers can occur. Taxa numbers may have increased over summer due to more food availability during the warmer, sunnier period. Taxa numbers were also higher than the median number for similar eastern hill country streams (15 taxa), and equal to the record (32 taxa) for all similar eastern hill country streams (TRC, 2017b). The site was in 'fair' health during both spring and summer at the time of surveys. There was no significant variation in MCI score between the two surveys and compared with the historical median.

4 General discussion and conclusions

The detection of trends in the biological data requires a data set of suitable period and collected using rigid, acceptable protocols, to be statistically valid e.g. a minimum of ten-years of spring and summer surveys. With 23 years of data available for most sites, temporal trend analyses have been updated further within this report. For the third time, there has also been analysis presented of the results from the most recent ten-year period for each site where available. This represents a compromise between degree of certainty in any apparent trends, and an indication of current as distinct from historical directions of travel. Other comments in relation to the data collected in the period 1995 to 2018, are presented briefly below. These data are summarised in Appendix II and illustrated in Figure 118 to Figure 124.

4.1 Macroinvertebrate fauna communities

In general terms, data have indicated that the macroinvertebrate communities at sites in upper reaches of catchments have been comprised of a greater proportion of taxa that are 'sensitive' to the effects of nutrient enrichment or a poorer state of habitat, compared with communities in the mid and lower reaches of catchments. These changes in community composition have resulted from the effects of nutrient enrichment, increased sunlight (less riparian shading), higher temperatures, increased algal growth (a partial consequence of the former), lower in-stream velocities, and finer substrate (sedimentation), coincident with poorer physicochemical water quality in the lower reaches of streams and rivers.

Taxa richness (number of different taxa) at most sites in these streams and rivers more often showed higher richness in the upper reaches of catchments (with the exception of those affected by preceding headwater erosion events), with more seasonal variability in richness further downstream. Seasonal richness often have tended to be higher in summer than in spring, particularly at lower reach sites.

Macroinvertebrate community index: Over the 23-year period, sites in the middle and the lower reaches of streams and rivers generally have had lower summer MCI scores than spring MCI scores as evidenced by overall decreases in mean scores by four units, whereas median seasonal scores at upper reach sites have differed by only one unit on average. This difference has been coincident with summer warmer water temperatures, increased periphyton substrate cover, and lower flows, resulting in additional less 'sensitive' taxa being present and/or increases in the abundance of lower scoring 'tolerant' taxa, combined with lifecycle patterns. Some taxa will be present in spring as large nymphs but will not be recorded in summer samples as they will be at an egg or first instar (usually impossible to ID to genus) stage.

Furthermore, the results from the 2017-2018 have shown that:

- The mean spring MCI score (108 units) was higher (by eight units) than the mean summer score (100 units), while the median spring score (105 units) was also eight units higher than the median summer score (97 units).
- A paired two sample t-test of spring and summer MCI scores showed that there was highly significant seasonal variation ($N = 59$, t-value = 5.88, $p < 0.01$).
- At upper reach sites there was an decrease in average MCI score of eight MCI units in summer which was highly statistically significant (($N = 23$, t-value = 3.07, $p < 0.01$).
- At mid reach sites, a decrease in average MCI score of nine units in summer was highly statistically significant (($N = 28$, t-value = 5.45, $p < 0.01$).
- At lower reach sites, a decrease in average MCI scores of four units in summer was significant (($N = 8$, t-value = 2.57, $p = 0.04$).
- The spring 2017 average MCI score was four units higher than long term (22 year) average of spring median scores, and this difference was significant ($N = 59$, t-value = 3.91, $p < 0.01$)

- The summer 2018 average MCI score was 0.5 units lower than the long term (22 year) average of summer median scores, and this difference was not significant (N = 59, t-value = -0.46, $p = 0.65$)
- The historical spring medians (104 MCI units) were significantly higher, by 3 MCI units on average, than the historical summer medians (101 MCI units) (N = 59, t-value = 7.28, $p < 0.01$)

There were seven new maxima MCI site scores recorded during the 2017-2018 period. This is similar to the six new maxima detected in the preceding 2016-2017 period. One site MCI score minima was recorded during the 2017-2018 period, the same as in the preceding year.

4.1.1 Spring and summer MCI values vs median values and predictive scores

The MCI scores from the spring and summer surveys are compared with the historical medians generated from 22 years of data (1995-2017) from the SEM programme and with two predictive scores (summarised in Appendix II): modelled based on distance from the National Park, and referenced against equivalent REC sites (national). Those sites' median MCI scores which deviated significantly (> 10 MCI units) from predicted scores are listed individually in Appendix II.

4.1.2 Spring surveys

4.1.2.1 Historical SEM

Forty-six of the 59 sites had spring MCI scores which were not significantly different (within ten units) to their historical medians. Eleven sites had a significantly better than normal score while two sites had significantly worse than normal scores (Figure 118). In addition, 13 sites had scores that were between five to ten units higher and four sites had scores that were between five to ten units lower than historical spring medians.

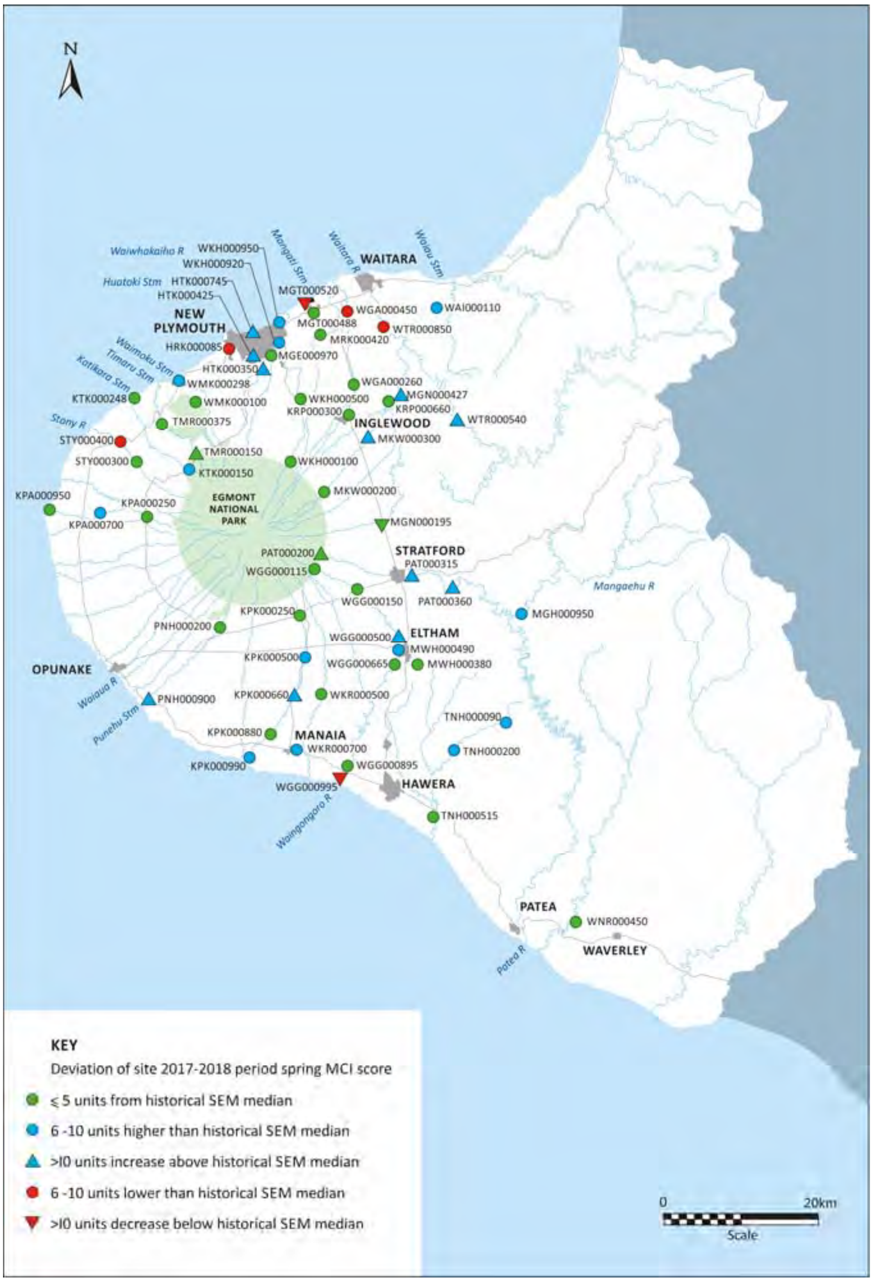


Figure 118 Spring 2017 MCI scores in relation to SEM historical spring median values

In summary, 78% of sites showed no significant differences (Stark, 1998) between spring, 2017 MCI scores and historical spring median scores, while 19% of sites had significantly higher and 3% of sites had significantly lower spring 2017 MCI scores.

4.1.2.2 Predictive TRC ringplain distance model (distance from Egmont National Park)

Predictive scores have been developed for ringplain sites (38 sites) with their sources inside the National Park in relation to distance from the National Park (Stark and Fowles, 2009). Spring scores have been assessed against predicted scores for distance in Figure 119.

Figure 119 Spring 2017 MCI scores in relation to predicted downstream distance scores

Twenty-five of the 38 sites had spring MCI scores which were not significantly different (within ten units) to their predicted MCI scores based on distance from the National Park. Twelve sites had spring MCI scores more than ten units above the distance predicted values while only one site had a score significantly lower than predicted. Eleven sites had a score between six to ten units above the predicted value while only one site had a score between six to ten units below the distance predictice value.

In summary, 66% of sites showed no significant difference (Stark, 1998) between spring 2017 scores and predicted distance (from the National Park) scores, while 32% of sites had significantly higher spring 2017 MCI scores and 3% of sites had a significantly lower spring 2017 score.

4.1.2.3 Spring MCI scores in relation to the REC predictive score

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

Spring MCI scores have been compared with the REC predictions for all 59 sites surveyd for spring 2017. REC predictions are calculated by averaging current MCI scores for a particular REC segment type as well as taking into account other additional environmental and physical factors (see Leathwick, 1998).

Seven sites had spring MCI scores more than ten units above predicted values (Figure 120) and eight sites had values significantly lower than predicted values. A further eleven sites had scores between six to ten units above the predicted value and five sites had scores between six to ten units below the predicted value.

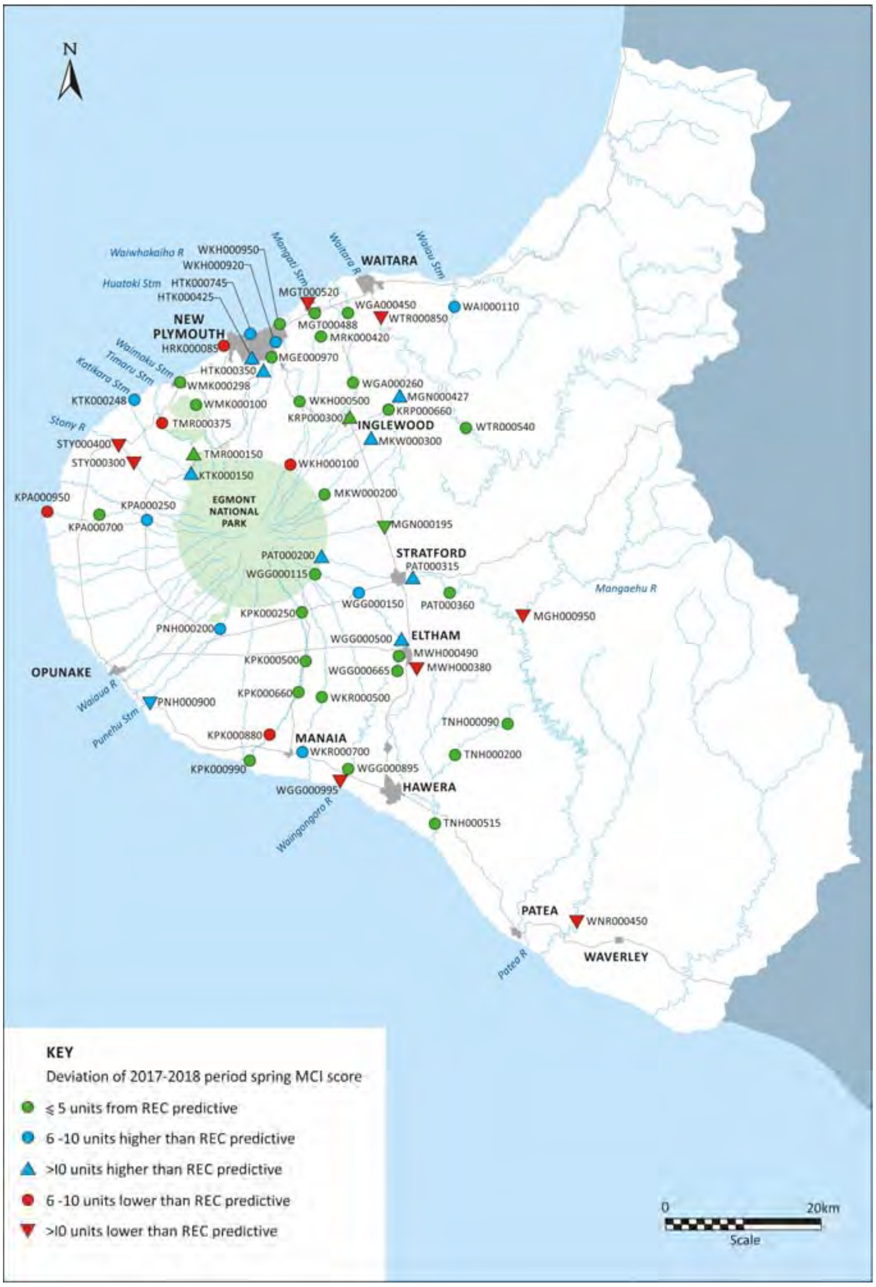


Figure 120 Spring 2017 MCI scores in relation to REC predictive values

In summary, 74% of sites showed no significant difference (Stark, 1998) between spring 2017 scores and predicted REC scores, while 12% of sites had significantly higher spring 2017 MCI scores and 14% of sites had a significantly lower than predicted spring 2017 scores.

4.1.3 Summer surveys

4.1.3.1 Historical SEM

A majority (50 of 59 sites) of sites' faunal communities' MCI scores were similar to (within 10 units) historical SEM site median scores (Figure 121). Significantly higher scores were found at four sites, while five sites had MCI scores significantly lower than their respective historical median score. A further eight sites had scores between six to ten units above the long-term value and five sites had scores between six to ten units below the long-term value.

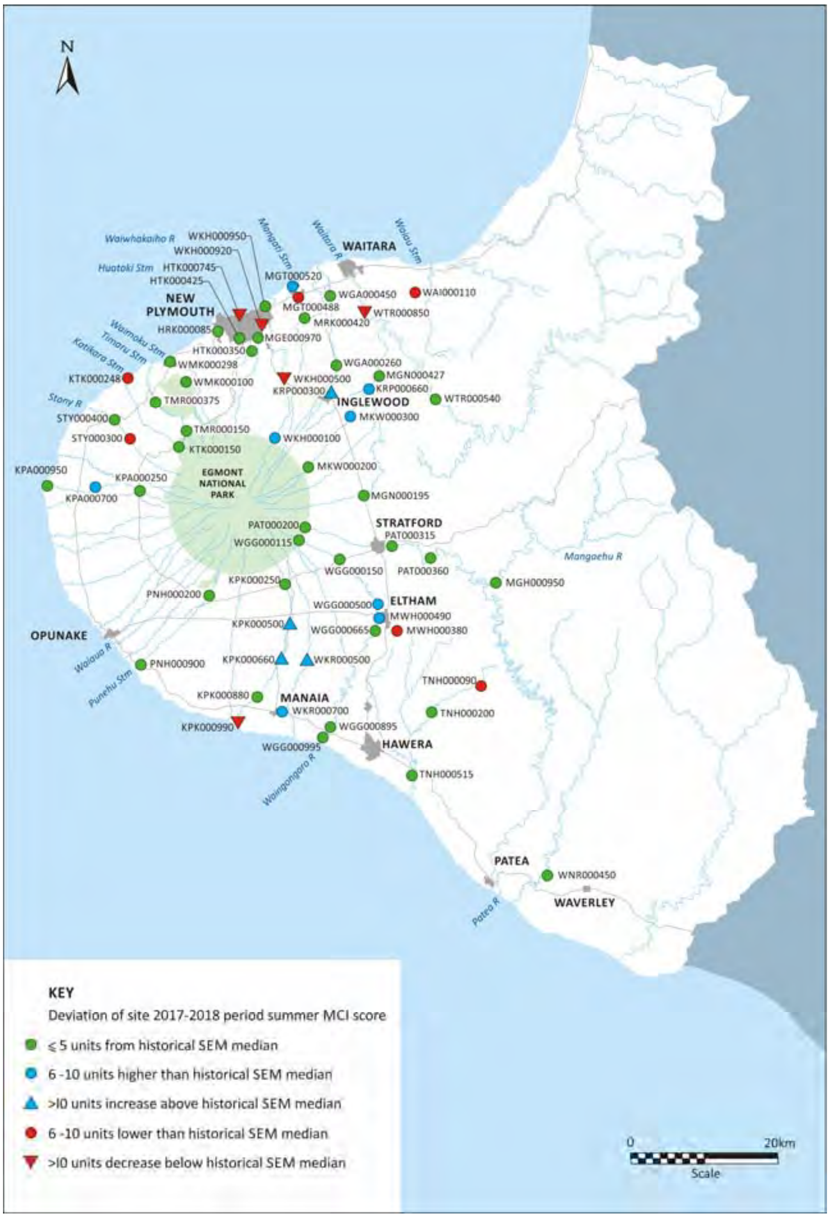


Figure 121 Summer 2018 MCI scores in relation to SEM historical median values

In summary, 85% of sites showed no significant differences (Stark, 1998) between summer 2018 MCI scores and historical median scores, while 7% of sites had significantly higher summer 2018 scores and 7% of sites had significantly lower summer 2017 scores.

4.1.3.2 Predictive TRC ringplain distance model

Summer scores for each ringplain site (38 sites) have been assessed against predicted scores (Stark and Fowles, 2009) for distance from the National Park boundary for those ringplain sites with sources inside the National Park. A majority (26 of 38 sites) of sites' faunal communities' MCI scores were similar to (within 10 units) their distance-based predictive scores (Figure 122).

Figure 122 Summer 2018 MCI scores in relation to predicted downstream distance scores

Eight sites had scores more than ten units above predicted values and four sites had scores more than ten units below predicted values. A further three sites had scores between six to ten units above the predicted value and seven sites had scores between six to ten units below the predicted value.

In summary, 68% of sites showed no significant difference (Stark, 1998) between summer 2018 MCI scores and predicted distance (from National Park) scores, while 21% of sites had significantly higher summer scores and 11% of sites had significantly lower summer scores.

4.1.3.3 Summer MCI scores in relation to the REC predictive scores

Summer MCI scores have been compared with the REC predictions for all 59 sites. REC predictions are calculated by averaging current MCI scores for a particular REC segment type as well as taking into account other additional environmental and physical factors (see Leathwick, 1998).

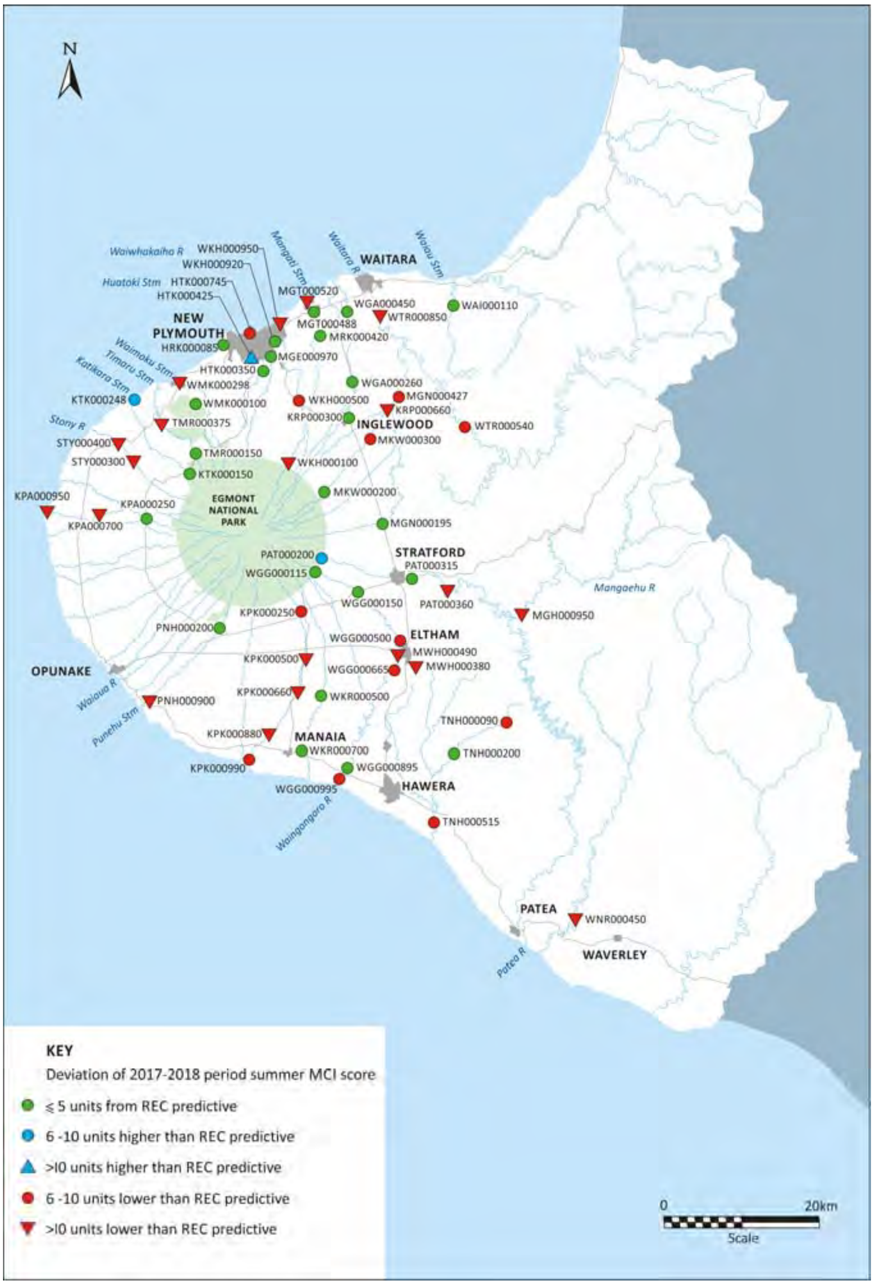


Figure 123 Summer 2018 MCI scores in relation to REC predictive values

One site had a summer MCI score more than ten units above predicted values (Figure 123) with 19 sites significantly lower than predicted. A further two sites had scores between six to ten units above the predicted value and 13 sites had scores between six to ten units below the predicted value.

Overall, Taranaki summer MCI scores were more likely to be below than above values that were derived from a national dataset.

In summary, 66% of sites showed no significant difference (Stark, 1998) between summer 2018 MCI scores and REC scores, while 2% of sites had significantly higher summer scores and 32% of sites had significantly lower summer scores.

4.1.3.4 Predictive value overview

The general seasonal trend in MCI scores is summarised in Table 64, which provides the percentages of sites' scores in relation to predicted scores.

Table 64 Percentages of spring and summer MCI scores for ringplain sites with sources arising in the National Park in relation to predicted distance from National Park boundary score (Stark and Fowles, 2009) and national REC-based scores (Lethwick, 1998)

Season	Spring 2017			Summer 2018		
Prediction	> 10 units higher	± 10 units	> 10 units lower	> 10 units higher	± 10 units	> 10 units lower
Distance REC	32% 12%	66% 74%	3% 14%	21% 2%	68% 66%	11% 32%

In general, MCI scores were more likely to be significantly higher than lower for predictive distance scores with the majority of sites not significantly different to predictive scores. This was probably due to sites having improved since the distance-based predictive equations were created using data from 1981-2006.

The more recently created REC predictive scores showed the opposite pattern for the summer survey, but this was fairly minor for the spring survey (Table 65). More sites were significantly lower than significantly higher than predictive scores though the majority were not significantly different (Stark, 1998) to predictive scores, which might indicate that Taranaki sites were in not as good a condition as general NZ sites. However, results are further complicated by the Council using Taranaki specific tolerance values compared with national values which may distort the analysis.

Table 65 Percentages of sites (2017-2018) showing significant differences (>10 MCI units) from the various predicted scores

Sites	Deviation from predicted scores			
	Distance[1]		REC[2]	
	Lower	Higher	Lower	Higher
Upper reaches	0%	13%	6%	6%
Mid reaches	0%	50%	36%	19%
Lower reaches	19%	8%	28%	0%
All sites	7%	30%	23%	7%

[Notes: Stark and Fowles, 2009[1]; Leathwick, 2008[2]]

A significant percentage of sites' scores differed significantly from predictions based on distance from the National Park boundary, with a greater proportion of actual scores higher than predicted. There was a marked difference in this pattern further downstream, with only 8% of sites in the lower reaches having a MCI score significantly above the predicted value. A similar pattern was observed for REC predictive values, with upper reach sites showing no tendency towards either lower and higher values while mid to lower reach sites were more likely to have significantly lower MCI values than comparative national values.

Table 66 Percentages of sites with historical medians (1995-2018) showing significant differences (>10 MCI units) from the various predicted scores

Sites	Deviation from medians			
	Distance[1]		REC[2]	
	Lower	Higher	Lower	Higher
Upper reaches	0%	14%	0%	0%
Mid reaches	0%	17%	32%	4%
Lower reaches	8%	0%	30%	0%
All sites	3%	11%	27%	2%

Sites in the lower reaches of shorter ringplain streams (e.g. Punehu, Kapoaiaia and, in particular the Waimoku Stream), have had historical median MCI scores showing the greatest disparity between actual and predicted scores for distance from the National Park (see Appendix II). Care needs to be used when comparing actual scores with predictive score as there is likely to be discrepancies, as predictive values are not likely to be perfect and give only a generalised indication of what a site's MCI score is likely to be.

Only one median MCI score (Huatoki Stream at the Domain, New Plymouth) significantly exceeded predicted scores based upon the REC system, whereas 27% of sites' scores were significantly lower. No upper reach sites had significantly lower or higher scores and the percentage significantly below the predictive score increased from the upper to the mid and lower reach sites. It should be noted in particular, the national (REC) predictive scores are based on samples collated without regard for the season of sampling, whereas this Council samples twice over the spring-summer period (uniquely amongst councils), and so summer MCI values will drag down the Council's overall scores when comparing with the national dataset. The maximum scores for each site in Taranaki (over the 1995 to 2018 period) are invariably recorded in spring and have often exceeded the REC predicted scores.

Ranking sites, on the basis of median SEM MCI scores for the 23-year period to date, may be attempted in terms of deviation from the predicted scores for distance from the National Park boundary (for ringplain sites) and REC predicted scores (for all sites). This effectively indicates which sites are 'better than expected' or 'worse than expected' once the particular characteristics of the site are taken into account (to the extent that these characteristics are accounted for in the modelling). Table 67 provides the rankings on this basis of the best and poorest sites in the SEM programme.

Table 67 Ranking of five best and worst sites' median MCI scores (1995-2018) based on deviation from predictive scores

	Distance from National Park	REC
BEST	Waingongoro R @ Opunake Rd	Huatoki S @ Domain
	Manganui R. SH3	Patea R @ Barclay Rd
	Patea R @ Barclay Rd	Kapoaiaia S @ Wiremu Rd
	Kaupokonui S @ Opunake Rd	Katikara S @ coast
	Waingongoro R @ SH45	Waingongoro R @ Opunake Rd
WORST	Waimoku S @ coast	Mangaehu Rd @ Raupuha Rd
	Kapoaiaia S @ coast	Whenuakura R @ Nicholson RD
	Punehu S @ SH 45	Mangati S @ Bell Block
	Kapoaiaia S @ Wataroa Rd	Kaupokonui S @ u/s Lactose Co.
	Waiwhakaiho R @ coast	Mangawhero S @ Eltham

The majority of the best ranked sites were located higher up the catchment. However, the Waingongoro River site at SH45 is located in the lower reach close to the coast. The site has good riparian vegetation and swift flow which probably contributed to its better than predicted score. The Huatoki Stream in the Domain at New Plymouth has extensive riparian cover provided by the Domain constituting of intact native bush, but is excluded from the distance ranking as this stream is sourced outside of the National Park.

The majority of the poorest ranked streams were located in the lower reaches of catchments with the Kapoaiaia Stream (with very limited riparian cover) notable for its poor ranking at two sites. The Mangaehu River and the two small, non-National Park sourced streams (Mangati and Mangawhero), which used to receive significant point source discharges rank poorly in terms of the REC predictions. (Note: these streams and river sites were excluded from the distance predictive rankings as these catchments are located well away from the National Park).

4.1.4 Stream 'health' categorisation

A gradation of biological water quality conditions based upon ranges of MCI scores has been used to determine the 'health' generically (Table 3) of each site by utilising the median score from up to a 23-year period (1995-2018). These assessments are summarised in Appendix II. The 'health' of streams in relation to the location of sites (upper, middle and lower reaches) in catchments is summarised in Table 68.

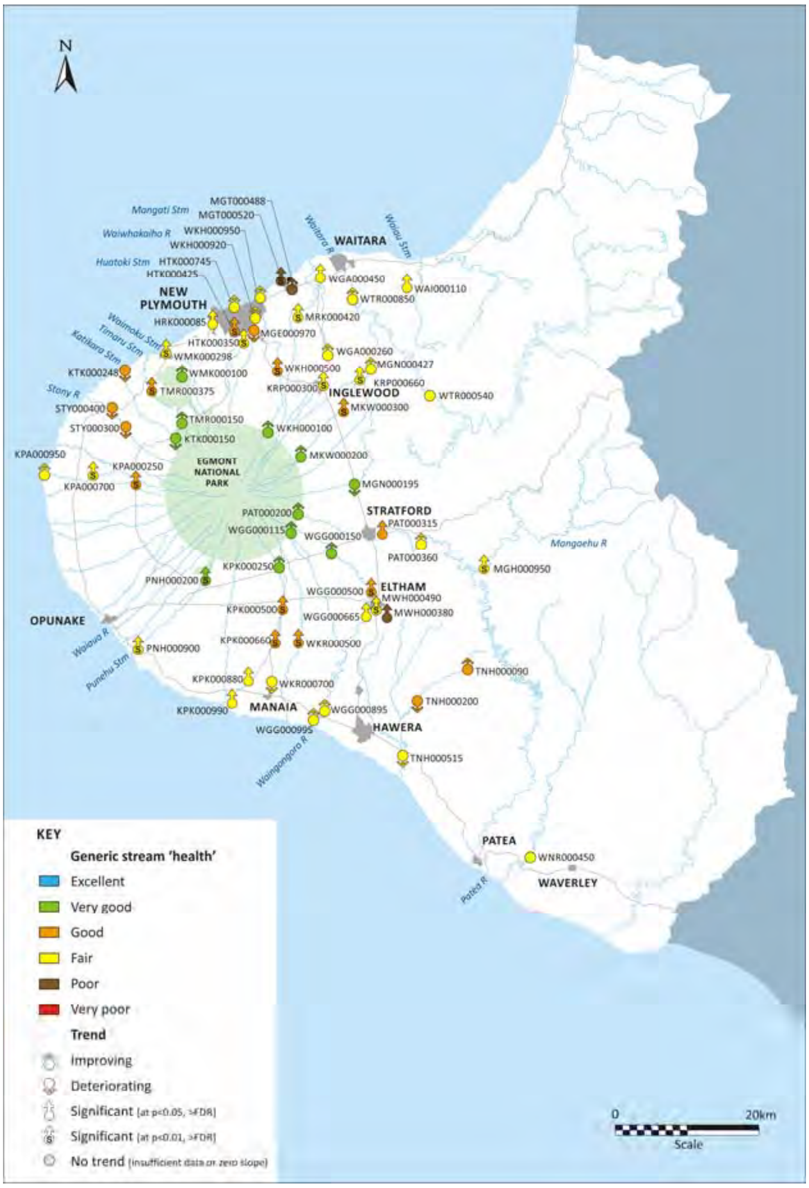


Figure 124 Generic biological 'health' (based on median MCI) and trends in biological quality for SEM sites, 1995 to 2018

Table 68 Stream 'health' site assessments according to catchment reach (in terms of median MCI score, 1995-2018

'Health' grading (Median MCI score range)	Reaches		
	Upper	Middle	Lower
Excellent (≥140)	0	0	0
Very good (120-139)	7	4	0
Good (100-119)	1	12	3
Fair (80-99)	0	11	18
Poor (60-79)	0	1	2
Very poor (<60)	0	0	0
Median ranges (MCI units)	100-138 (38)	74-130 (55)	67-108 (41)

Typically generic 'health' (in terms of median MCI scores) decreases in a downstream direction from 'very good' in the upper reaches of catchments, through predominantly 'good-fair' in the middle reaches, to mainly 'fair' in the lower reaches toward the coast. Each site's 'health' may vary between seasons, but seldom by no more than one category (grading) either side of this median grading in response to preceding stream flow and associated habitat (physical and physicochemical water quality) conditions. In this regard generally there has been a similar level of seasonal variability in scores between middle and lower catchment sites. Upper catchment sites tend to show far less variability. However, there were also far fewer upper reach sites surveyed compared with middle or lower reach sites which limits the usefulness of direct comparisons examining total variability.

The Government's *National Policy Statement for Freshwater Management 2014*, as amended in 2017, does not specify a 'bottom line', or minimum standard, for MCI. However, it does specify that a council must establish '*methods…to respond to a Macroinvertebrate Community Index score below 80'*. The grounds given for this requirement are the more general requirement that councils must establish methods for responding to any monitoring results that indicate freshwater objectives will not be met (one compulsory objective being that ecosystem processes are safeguarded) and/or that values will not be provided for (the relevant compulsory value being ecosystem health). While there are only three sites that have a median MCI value of less than 80, the Council is in any case pursuing methods that are confidently expected to lift MCI values across the ring plain, namely the substantial elimination of discharges of dairy effluent to waterways together with the completion of the Council's riparian management programme in association with the farming community.

4.1.5 Comments

The decreasing gradient of stream 'health', from 'very good' in the upper reaches of ringplain streams to 'fair' in the lower reaches, is indicative of a downstream change in macroinvertebrate communities towards those that are comprised of taxa more 'tolerant' of organic enrichment and/or physical habitat deterioration in the lower reaches. These communities have become well adapted to the cumulative impacts of upstream point source discharges and diffuse run-off and are particularly resistant to further impacts (other than toxic discharges). Therefore, in most lower reach communities significant improvement of water quality and habitat would have to occur before changes would be statistical and ecological significant.

Thus, while maintenance of ('fair') stream 'health' occurs in the lower reaches of ringplain catchments (as these communities are very 'tolerant' of cumulative organic impacts), temporal trends of improvement in stream 'health' are unlikely to be statistically evident until appropriate management initiatives are substantially progressed on a catchment wide basis. However, of the three sites that are graded 'poor', all three have positive trends with one showing very significant improvement (Figure 124). Enhancement of stream health, particularly at the sites in the lower reaches of ringplain streams, is unlikely to be significant and/or important until marked improvements in habitat and water quality occur. These may be implemented for instance by way of a combination of riparian fencing/planting initiatives and re-direction of dairy pond treatment system discharges from direct disposal into surface waters to irrigation to land.

4.2 Macroinvertebrate fauna MCI trends

Temporal trends measured over the monitoring period between 1995 and 2018 (Table 69, and Appendix II) indicated that 27 sites had significantly improving MCI scores (FDR $p<5\%$) with 20 of those sites having highly significantly MCI scores (FDR $p < 1\%$)[3] during the period. No sites had a significantly deteriorating

[3] FDR= one of the methods used to make the statistical analysis more stringent, by eliminating cases where a random distribution of results might create a pattern that appears meaningful.

trend after FDR application. Two sites could not be trended due to the shorter duration of monitoring at these sites.

Forty-eight sites show a positive (improving) trend, while nine had a negative (decreasing) trend across the full dataset.

For the most recent 10-year period, no sites had a significant trend after FDR application. There were 30 sites that had a positive trend and 27 that had a negative trend.

Table 69 Summary of Mann-Kendall test results for MCI scores trended over time (1995-2018) for 59 Taranaki streams/rivers (p with FDR applied) (significant = $p < 0.05$ and highly significant = $p < 0.01$)

River/stream name	Site code	N	FDR[3] p level	+/- (ve)	Significance	Trendline MCI range
Hangatahua (Stony) R	STY000300	45	0.13	-ve	Not significant	15
Hangatahua (Stony) R	STY000400	45	0.86	-ve	Not significant	16
Herekawe S	HRK000085	45	0.04	+ve	Significant	10
Huatoki S	HTK000350	43	<0.01	+ve	Highly significant	18
Huatoki S	HTK000425	43	<0.01	+ve	Highly significant	12
Huatoki S	HTK000745	43	0.90	+ve	Not significant	13
Kapoaiaia S	KPA000250	38	<0.01	+ve	Highly significant	28
Kapoaiaia S	KPA000700	38	<0.01	+ve	Highly significant	28
Kapoaiaia S	KPA000950	38	0.07	+ve	Not significant	13
Katikara S	KTK000150	37	0.08	-ve	Not significant	8
Katikara S	KTK000248	35	0.77	+ve	Not significant	11
Kaupokonui R	KPK000250	39	0.13	+ve	Not significant	6
Kaupokonui R	KPK000500	42	<0.01	+ve	Highly significant	20
Kaupokonui R	KPK000660	46	<0.01	+ve	Highly significant	33
Kaupokonui R	KPK000880	46	0.02	+ve	Significant	15
Kaupokonui R	KPK000990	38	0.04	+ve	Significant	14
Kurapete S	KRP000300	45	<0.01	+ve	Highly significant	19
Kurapete S	KRP000660	45	<0.01	+ve	Highly significant	24
Maketawa S	MKW000200	36	0.94	+ve	Not significant	12
Maketawa S	MKW000300	35	<0.01	+ve	Highly significant	18
Mangaehu R	MGH000950	46	<0.01	+ve	Highly significant	19
Manganui R	MGN000195	46	0.25	-ve	Not significant	9
Manganui R	MGN000427	46	0.55	+ve	Not significant	7
Mangaoraka S	MRK000420	45	<0.01	+ve	Highly significant	16
Mangati S	MGT000488	45	0.65	+ve	Not significant	9
Mangati S	MGT000520	45	<0.01	+ve	Highly significant	22

River/stream name	Site code	N	FDR[3] p level	+/- (ve)	Significance	Trendline MCI range
Mangawhero S	MWH000380	46	0.05	+ve	Highly significant	6
Mangawhero S	MWH000490	46	<0.01	+ve	Highly significant	18
Mangorei S	MGE000970	31	0.23	-ve	Not significant	7
Patea R	PAT000200	46	0.23	+ve	Not significant	7
Patea R	PAT000315	46	0.04	+ve	Significant	11
Patea R	PAT000360	46	0.28	+ve	Not significant	3
Punehu S	PNH000200	46	<0.01	+ve	Highly significant	13
Punehu S	PNH000900	46	<0.01	+ve	Highly significant	18
Tangahoe R	TNH000090	22	0.14	+ve	Not significant	8
Tangahoe R	TNH000200	22	0.86	-ve	Not significant	8
Tangahoe R	TNH000515	22	0.77	+ve	Not significant	8
Timaru S	TMR000150	45	0.23	+ve	Not significant	9
Timaru S	TMR000375	45	<0.01	+ve	Highly significant	19
Waiau S	WAI000110	38	0.01	+ve	Significant	11
Waimoku S	WMK000100	37	0.90	+ve	Not significant	5
Waimoku S	WMK000298	37	<0.01	+ve	Highly significant	13
Waingongoro R	WGG000115	46	0.22	+ve	Not significant	8
Waingongoro R	WGG000150	46	0.53	+ve	Not significant	12
Waingongoro R	WGG000500	46	<0.01	+ve	Highly significant	10
Waingongoro R	WGG000665	46	0.01	+ve	Significant	12
Waingongoro R	WGG000895	46	0.79	+ve	Not significant	5
Waingongoro R	WGG000995	46	0.11	+ve	Not significant	11
Waiokura S	WKR000500	27	<0.01	+ve	Highly significant	11
Waiokura S	WKR000700	22	0.55	-ve	Not significant	9
Waiongana S	WGA000260	45	0.09	+ve	Not significant	8
Waiongana S	WGA000450	45	0.01	+ve	Significant	19
Waitara R	WTR000540	6	N/T	-	-	-
Waitara R	WTR000850	45	0.13	+ve	Not significant	17
Waiwhakaiho R	WKH000100	31	0.28	+ve	Not significant	6
Waiwhakaiho R	WKH000500	45	<0.01	+ve	Highly significant	13
Waiwhakaiho R	WKH000920	45	0.97	+ve	Not significant	11
Waiwhakaiho R	WKH000950	43	0.78	+ve	Not significant	6
Whenuakura R	WNR000450	6	N/T	-	-	-

[Not significant = not statistically significant (ie p≥ 0.05), Significant = significant after FDR applied (at p < 0.05), Highly significant = significant after FDR applied (at p < 0.01); -ve = negative trend, +ve = positive trend]

Each of these site's trends is discussed more fully in the site section of the report. In general, all but one of the sites that had a significant trend exhibited a broad range of MCI scores across the moving average trendline over the 23-year SEM monitoring period which suggested trends which were ecologically significant. Those sites with the strongest positive improvement over the 23-year monitoring period, coupled with a large increase in MCI scores have been:

- Kaupokonui Stream upstream of Fonterra, Kapuni factory
- Mangaehu River at Raupuha Road
- Punehu Stream at SH45
- Kapoaiaia Stream at Wiremu Road
- Mangawhero Stream upstream of Waingongoro River confluence
- Kaupokonui Stream upstream of Kaponga WWTP
- Kapoaiaia Stream at Wataroa Road
- Mangati Stream at Bell Block
- Timaru Stream at SH45
- Huatoki Stream at Hadley Drive
- Waiongana Stream at SH3
- Mangaoraka Stream at Corbett Road
- Kurapete Stream upstream of Inglewood WWTP
- Waiwhakaiho River at SH 3
- Waingongoro River at Stuart Road
- Waingongoro River at SH45

5 Summary

The 2017-2018 period was the 23rd year of the macroinvertebrate state of the environment monitoring (SEM) programme. Sampling was conducted between October to December 2017 for spring samples and February to April 2018 for summer samples. This report describes the macroinvertebrate communities at 59 sites established through the Taranaki region (TRC, 1995b). These include the additional riparian monitoring sites in the Katikara and Kapoaiaia Streams and the sites in the Maketawa Stream and Waiwhakaiho catchment with the two sites monitored for consent purposes in the Kurapete Stream also included. Sites in the Waiokura Stream and Tangahoe River were also added to the programme in the 2007-2008 period and a site in the lower Herekawe Stream in 2008-2009 (although this site has a lengthy historical consent monitoring record spanning the 1995 to 2008 period). In addition, two new eastern hill country sites were added in the 2015-2016 period in the middle reaches of the Waitara River and lower reaches of the Whenuakura River.

Results are discussed in terms of macroinvertebrate community composition, richness and MCI scores, which are compared with prior SEM data, and stream 'health' is assessed using generic and predictive methodologies. Trends are identified where possible, and results are discussed in relation to historical data and where applicable also in relation to distance from the National Park (Stark and Fowles, 2009) and the REC system (J Leathwick, pers comm.). Discussion of temporal trends over the 23 years and most recent ten-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 there was a large change in condition as evidenced by the trendline encompassing a wide range of MCI scores. 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 2016-2017 report

In the 2016-2017 report, it was recommended:

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2017-2018 monitoring year by means of the same programme to that undertaken in 2016-2017;
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

These recommendations have been implemented in the 2017-2018 year under review and per this report.

7 Recommendations for 2018-2019

It is recommended for 2018-2019:

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2018-2019 monitoring year by means of the same programme to that undertaken in 2017-2018;
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

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The Job Manager for the programme was Darin Sutherland (Environmental Scientist) who was the main author of this Annual Report. Assisstance in writing the report was given by Katie Blakemore (Technical Officer). Kelby Clements updated Appendix I. All field sample collections were performed by Darin Sutherland and Bart Jansma (Environmental Scientists). Macroinvertebrate sample processing was undertaken by Biosortid Ltd. (under contract to the Taranaki Regional Council) with quality control undertaken by an external contractor. The report was checked for formatting by Haidie Burchell-Burger (Administration Officer) and some figures were produced with assistance from Kathryn Mischefski (Graphics Officer). The report was reviewed by Fiza Hafiz.

Bibliography and references

Biggs, BJF, 2000: New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams. Prepared for Ministry for the Environment. NIWA, Christchurch, New Zealand. 122 pp.

Biggs, BJF and Kilroy C, 2000: Stream Periphyton Monitoring Manual. Published for Ministry for the Environment. NIWA, Christchurch, New Zealand. 228 pp.

Collier, KJ; Winterbourn, MJ, 2000 (eds.): New Zealand stream invertebrates: ecology and implications for management. NZ Limnological Society, Christchurch. 415pp.

Death, RG, 2000: Invertebrate-substratum relationships. In: Collier, KJ; Winterbourn, MJ eds. New Zealand stream invertebrates: ecology and implications for management. New Zealand Limnological Society, Christchurch. Pp 157-178.

Fowles, CR, 2014: Baseline biomonitoring of lower reach sites in three intensive dairying southwestern ring plain catchments (Heimama, Hiniwera, and Mangatawa Streams), surveyed January 2014. TRC Internal Report CF598.

Leathwick, J, Julian, K, and Smith, B. 2009: Predicted national-scale distributions of freshwater macroinvertebrates in all New Zealand's rivers and streams. NIWA Client Report HAM2009-042. 69pp.

Ryan, PA, 1991: Environmental effects of sediment on New Zealand streams, a review. NZ Journal of Marine and Freshwater Research, Vol 25, 207-221.

Snelder, T, Biggs, B, Weatherhead, M, 224: New Zealand River Environment Classification User Guide. MfE publication. 145p.

Stark, JD, 1985: A macroinvertebrate community index of water quality for stony streams. Water and Soil Miscellaneous Publication No. 87.

Stark, JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research 32(1):* 55-66.

Stark, JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron Report No. 472. 32pp.

Stark, JD, 2003: The water quality and biological condition of the Maketawa catchment. Cawthron Report No 742. 70pp.

Stark, JD 2000; Boothroyd, IKG, 2000: Use of invertebrates in monitoring. In Collier KJ; Winterbourn, MJ eds. New Zealand Stream Invertebrates: ecology and implications for management. NZ Limnological Society, Chch. Pp 344-373.

Stark, JD; Boothroyd, IKG; Harding, JS; Maxted JR; Scarsbrook, MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No 1. Prepared for Ministry for the Environment. Sustainable Management Fund Project No 5103 57p.

Stark, JD and Fowles, CR, 2006: An approach to the evaluation of temporal trends in Taranaki state of the environment macroinvertebrate data. Cawthron Institute Report No 1135. 88p.

Stark, JD and Fowles, CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain streams. Stark Environmental Report No 2009-01 47p.

Stark, JD and Fowles, CR, 2015: A re-appraisal of MCI tolerance values for macroinvertebrates in Taranaki ringplain streams, Stark Environmental Report No 2015-03 38p.

Stark, JD and Maxted, JR, 2007: A user guide for the MCI. Cawthron Report No 1166. 56p.

TCC, 1984. Freshwater biology. Taranaki ring plain water resources survey. Taranaki Catchment Commission Report. 196p.

TRC, 1994: Regional Policy Statement for Taranaki. Taranaki Regional Council.

TRC, 1995a: Freshwater macroinvertebrate community data: a review of the results of biomonitoring surveys undertaken between 1980 and 1995. TRC internal report.

TRC, 1995b: Regional Monitoring Strategy for Taranaki Part II: Proposed State of the Environment Monitoring Programme. TRC internal report.

TRC, 1996a: State of the environment regional water quality monitoring network for Taranaki. Biological sampling techniques for freshwater rivers and streams. TRC internal report.

TRC, 1996b: State of the Environment - Taranaki Region 1996. Taranaki Regional Council.

TRC, 1997a: State of the Environment Procedures Document. TRC internal report.

TRC, 1997b: State of the Environment regional water quality monitoring network for Taranaki. Biological sampling techniques for freshwater rivers and streams. TRC internal report.

TRC, 1997c: Annual SEM Report 1995-96 Fresh water biological monitoring programme. Technical report 97-96.

TRC, 1998: Freshwater biological monitoring programme. Annual SEM Report 1996-97. Technical Report 97-100.

TRC, 1999: Freshwater biological monitoring programme. Annual SEM Report 1997-98. Technical Report 99-06.

TRC, 2000: Fresh water biological monitoring programme Annual SEM Report 1998-99. Technical Report 99-90.

TRC, 2001: Fresh water biological monitoring programme Annual SEM Report 1999-2000, Technical Report 2000-40.

TRC, 2002a: Fresh water biological monitoring programme Annual SEM Report 2000-2001, Technical Report 2001-87.

TRC, 2002b: Fresh water biological monitoring programme Annual SEM Report 2001-2002, Technical Report 2002-46.

TRC, 2003a: Taranaki – Our Place, Our Future, Report on the state of the environment of the Taranaki region – 2003. TRC, 206pp.

TRC, 2003b: Fresh water biological monitoring programme Annual SEM Report 2002-2003, Technical Report 2003-18.

TRC, 2004a: Fresh water biological monitoring programme Annual SEM Report 2003-2004, Technical Report 2004-23.

TRC, 2005: Fresh water biological monitoring programme Annual SEM Report 2004-2005, Technical Report 2005-72.

TRC, 2006a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report 2005-2006, Technical Report 2006-94.

TRC, 2006b: An interpretation of the reasons for statistically significant temporal trends in macroinvertebrate (MCI) SEM data in the Taranaki region 1995-2005. TRC Internal Report.

TRC, 2006c: A review of macroinvertebrate monitoring data for large hill country catchments in the Taranaki region. TRC Internal Report.

TRC, 2007a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report 2006-2007, Technical Report 2007-22.

TRC, 2007b: Taranaki Regional Council freshwater biology methods manual Version 3. TRC Internal Report.

TRC, 2008: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report 2007-2008, Technical Report 2008-75.

TRC, 2009a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2008–2009, Technical Report 2009-14.

TRC, 2009b: Taranaki-Where We Stand. State of the environment report. TRC, 282 p.

TRC, 2010: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2009–2010, Technical Report 2010-16.

TRC, 2011a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2010–2011, Technical Report 2011-38.

TRC, 2011b: Freshwater physicochemical programme. State of the Environment Monitoring Annual Report 2010-2011. Technical Report 2011-47.

TRC, 2012a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2011–2012, Technical Report 2012-18.

TRC, 2012b: Freshwater physicochemical programme. State of the Environment Monitoring Annual Report 2011-2012. Technical Report 2012-27.

TRC, 2013a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2012–2013, Technical Report 2013-48.

TRC, 2013b: Freshwater physicochemical programme. State of the Environment Monitoring Annual Report 2012-2013. Technical Report 2013-49.

TRC, 2014a: Freshwater physicochemical programme. State of the Environment Monitoring Annual Report 2013-2014. Technical Report 2014-23.

TRC, 2014b: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2013–2014, Technical Report 2014-28.

TRC, 2015a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2014–2015, Technical Report 2015-66.

TRC, 2015b: Taranaki - as one. State of the environment report 2015 TRC, 267p.

TRC, 2016: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2015–2016, Technical Report 2016-33.

TRC, 2017a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2016–2017, Technical Report 2017-88.

TRC, 2017b: A brief statistical summary of Taranaki freshwater macroinvertebrate surveys for the period January 1980 to July 2017. TRC internal report.

Wilcock RJ, Betteridge K, Shearman D, Fowles CR, Scarsbrook MR, Thorrold BS and Costall D, 2009 : Riparian protection and on-farm best management practices for restoration of a lowland stream in an intensive dairy farming catchment: a case study. NZJ of Marine and Freshwater Research 43: 803-818.

Appendix I

Macroinvertebrate faunal 2017-2018 tables

Table 70 Macroinvertebrate fauna of the Hangatahua (Stony) River: spring SEM survey sampled on 30 October 2017

Taxa List	Site Code	MCI score	STY000300	STY000400
	Sample Number		FWB17376	FWB17377
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	A	C
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	R	-
	Zelandobius	5	-	R
	Zelandoperla	8	-	R
COLEOPTERA (BEETLES)	Elmidae	6	C	-
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	R	R
	Hydropsyche (Orthopsyche)	9	-	R
DIPTERA (TRUE FLIES)	Eriopterini	5	R	R
	Chironomus	1	-	R
	Maoridiamesa	3	C	C
	Orthocladiinae	2	A	A
	Empididae	3	-	R
	Ephydridae	4	R	R
		No of taxa	8	11
		MCI	110	100
		SQMCI	5.0	3.6
		EPT (taxa)	3	5
		%EPT (taxa)	38	45
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 71 Macroinvertebrate fauna of the Hangatahua (Stony) River: summer SEM survey sampled on 28 February 2018

Taxa List	Site Code	MCI score	STY000300	STY000400
	Sample Number		FWB18093	FWB18094
ANNELIDA (WORMS)	Oligochaeta	1	-	R
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	A	VA
	Nesameletus	9	-	R
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	C	C
COLEOPTERA (BEETLES)	Elmidae	6	-	R
	Staphylinidae	5	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	R
	Costachorema	7	-	R
	Hydrobiosis	5	-	R
	Pycnocentrodes	5	R	R
DIPTERA (TRUE FLIES)	Orthocladiinae	2	R	R
	Empididae	3	-	R
	Muscidae	3	R	-
		No of taxa	5	12
		MCI	104	105
		SQMCI	7.5	7.7
		EPT (taxa)	3	7
		%EPT (taxa)	60	58
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 72 Macroinvertebrate fauna of the Herekawe Stream: spring SEM survey sampled 24 October 2017 and summer SEM survey sampled 8 February 2018

Taxa List	Site Code	MCI	HRK000085	HRK000085
	Sample Number	**score**	**FWB17310**	**FWB18041**
NEMERTEA	Nemertea	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	C	C
	Lumbricidae	5	R	-
MOLLUSCA	*Potamopyrgus*	4	A	VA
CRUSTACEA	Ostracoda	1	-	C
	Paracalliope	5	R	A
	Talitridae	5	R	-
	Paranephrops	5	R	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C
	Coloburiscus	7	R	R
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	-	R
	Zelandobius	5	R	-
COLEOPTERA (BEETLES)	Elmidae	6	C	C
	Staphylinidae	5	R	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	-
	Hydrobiosis	5	R	R
	Psilochorema	6	-	R
	Oxyethira	2	R	C
	Triplectides	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	R
	Chironomus	1	R	R
	Orthocladiinae	2	A	C
	Polypedilum	3	C	R
	Tanypodinae	5	-	R
	Empididae	3	R	-
	Ephydridae	4	R	-
	Austrosimulium	3	R	A
		No of taxa	21	20
		MCI	83	85
		SQMCI	3.7	3.9
		EPT (taxa)	5	6
		%EPT (taxa)	24	30
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 73 Macroinvertebrate fauna of the Huatoki Stream: spring SEM survey sampled on 24 October 2017

Taxa List	Site Code	MCI score	HTK000350	HTK000425	HTK000745
	Sample Number		**FWB17307**	**FWB17308**	**FWB17309**
ANNELIDA (WORMS)	Oligochaeta	1	-	C	A
MOLLUSCA	*Potamopyrgus*	4	R	C	A
CRUSTACEA	Isopoda	5	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	VA	R
	Coloburiscus	7	VA	VA	R
	Deleatidium	8	VA	A	VA
	Ichthybotus	8	-	R	-
	Nesameletus	9	VA	R	-
	Zephlebia group	7	A	A	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	A	C	A
	Zelandoperla	8	R	C	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	VA
	Ptilodactylidae	8	-	R	-
	Scirtidae	8	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A	-
	Costachorema	7	R	-	-
	Hydrobiosis	5	-	R	-
	Hydrobiosella	9	-	R	-
	Confluens	5	C	C	-
	Pycnocentria	7	-	C	R
	Pycnocentrodes	5	C	C	A
	Triplectides	5	-	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	-	R
	Eriopterini	5	-	-	R
	Orthocladiinae	2	C	R	R
	Polypedilum	3	R	C	C
	Tanytarsini	3	-	-	C
	Austrosimulium	3	R	R	-
	Tanyderidae	4	-	R	-
		No of taxa	19	24	17
		MCI	113	117	102
		SQMCI	7.4	6.6	6.0
		EPT (taxa)	11	14	8
		%EPT (taxa)	58	58	47
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

Table 74 Macroinvertebrate fauna of the Huatoki Stream: summer SEM survey sampled on 8 February 2018

Taxa List	Site Code	MCI score	HTK000350	HTK000425	HTK000745
	Sample Number		FWB18038	FWB18039	FWB18040
NEMERTEA	Nemertea	3	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	C	C	A
MOLLUSCA	*Latia*	5	R	R	-
	Potamopyrgus	4	R	VA	XA
	Sphaeriidae	3	-	-	R
CRUSTACEA	Ostracoda	1	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	A	-
	Coloburiscus	7	VA	VA	R
	Deleatidium	8	VA	A	-
	Nesameletus	9	C	R	-
	Zephlebia group	7	R	A	-
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	-	R	-
	Zelandoperla	8	-	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	XA
	Ptilodactylidae	8	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	VA	-
	Hydrobiosis	5	C	C	-
	Neurochorema	6	R	-	-
	Confluens	5	R	-	-
	Oxyethira	2	C	-	R
	Pycnocentria	7	-	A	-
	Pycnocentrodes	5	VA	R	-
	Triplectides	5	-	C	-
DIPTERA (TRUE FLIES)	Eriopterini	5	-	-	R
	Chironomus	1	-	-	R
	Orthocladiinae	2	VA	C	-
	Polypedilum	3	-	C	-
	Tanytarsini	3	A	-	-
	Empididae	3	-	R	-
	Muscidae	3	R	-	-
	Austrosimulium	3	R	A	-
	Tanyderidae	4	-	-	R
ACARINA (MITES)	Acarina	5	-	R	-
		No of taxa	21	23	11
		MCI	97	108	75
		SQMCI	5.3	5.3	4.9
		EPT (taxa)	10	12	1
		%EPT (taxa)	48	52	9
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

Table 75 Macroinvertebrate fauna of the Kapoaiaia Stream: spring SEM survey sampled on 31 October 2017

Taxa List	Site Code	MCI score	KPA000250	KPA000700	KPA000950
	Sample Number		**FWB17386**	**FWB17387**	**FWB17388**
ANNELIDA (WORMS)	Oligochaeta	1	R	R	A
	Lumbricidae	5	R	-	-
MOLLUSCA	*Potamopyrgus*	4	-	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R	R
	Coloburiscus	7	VA	C	R
	Deleatidium	8	XA	XA	VA
	Nesameletus	9	A	C	-
	Zephlebia group	7	C	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	C	R
	Austroperla	9	R	-	-
	Zelandobius	5	C	C	C
	Zelandoperla	8	A	-	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	R	C
	Hydraenidae	8	C	-	-
	Ptilodactylidae	8	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	C	A
	Costachorema	7	C	C	C
	Hydrobiosis	5	-	R	C
	Plectrocnemia	8	R	-	-
	Beraeoptera	8	A	C	-
	Helicopsyche	10	C	-	-
	Olinga	9	C	-	-
	Pycnocentrodes	5	VA	A	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C	C
	Eriopterini	5	C	-	-
	Chironomus	1	R	C	C
	Maoridiamesa	3	C	A	A
	Orthocladiinae	2	C	A	VA
	Empididae	3	R	R	-
	Ephydridae	4	-	-	C
	Muscidae	3	-	-	R
	Austrosimulium	3	-	R	R
ACARINA (MITES)	Acarina	5	-	R	-
		No of taxa	27	23	19
		MCI	120	103	93
		SQMCI	7.2	7.3	4.6
		EPT (taxa)	16	11	9
		%EPT (taxa)	59	48	47
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

Table 76 Macroinvertebrate fauna of the Kapoaiaia Stream: summer SEM survey sampled on 5 March 2018

Taxa List	Site Code	MCI score	KPA000250	KPA000700	KPA000950
	Sample Number		FWB18143	FWB18144	FWB18145
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	-	R
NEMERTEA	Nemertea	3	-	-	C
ANNELIDA (WORMS)	Oligochaeta	1	C	C	VA
MOLLUSCA	*Physa*	3	-	-	R
	Potamopyrgus	4	C	C	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A	R
	Coloburiscus	7	A	VA	-
	Deleatidium	8	XA	VA	R
	Nesameletus	9	C	R	-
	Zephlebia group	7	R	C	-
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	C	R	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	A	A
	Hydraenidae	8	C	-	-
	Ptilodactylidae	8	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	VA	A
	Costachorema	7	C	-	-
	Hydrobiosis	5	C	C	C
	Beraeoptera	8	A	C	-
	Olinga	9	C	-	-
	Oxyethira	2	-	C	C
	Pycnocentrodes	5	A	VA	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	C	R
	Limonia	6	R	-	-
	Maoridiamesa	3	C	C	-
	Orthocladiinae	2	XA	A	VA
	Tanytarsini	3	-	C	A
	Empididae	3	R	R	-
	Ephydridae	4	R	-	R
	Muscidae	3	C	R	C
	Austrosimulium	3	-	C	R
	Tanyderidae	4	-	-	R
		No of taxa	24	23	20
		MCI	113	103	82
		SQMCI	5.2	5.7	2.6
		EPT (taxa)	12	10	5
		%EPT (taxa)	50	43	25
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

Table 77 Macroinvertebrate fauna of the Katikara Stream: spring SEM survey sampled on 24 October 2017

Taxa List	Site Code	MCI score	KTK000150	KTK000248
	Sample Number		FWB17312	FWB17313
ANNELIDA (WORMS)	Oligochaeta	1	-	C
MOLLUSCA	*Potamopyrgus*	4	-	R
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	R	-
	Ameletopsis	10	R	-
	Austroclima	7	R	C
	Coloburiscus	7	C	C
	Deleatidium	8	VA	VA
	Nesameletus	9	A	-
	Zephlebia group	7	R	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R
	Austroperla	9	R	-
	Megaleptoperla	9	R	-
	Stenoperla	10	R	-
	Zelandobius	5	A	A
	Zelandoperla	8	C	-
COLEOPTERA (BEETLES)	Elmidae	6	R	A
	Hydraenidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	C
	Costachorema	7	R	A
	Hydrobiosis	5	R	R
	Hydrobiosella	9	R	R
	Hydropsyche (Orthopsyche)	9	R	-
	Beraeoptera	8	-	R
	Pycnocentria	7	R	-
	Pycnocentrodes	5	-	XA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C
	Eriopterini	5	R	R
	Chironomus	1	-	C
	Maoridiamesa	3	-	C
	Orthocladiinae	2	A	A
	Polypedilum	3	-	C
	Tanytarsini	3	-	R
	Austrosimulium	3	-	R
		No of taxa	23	25
		MCI	143	102
		SQMCI	7.1	5.4
		EPT (taxa)	18	12
		%EPT (taxa)	78	48
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 78 Macroinvertebrate fauna of the Katikara Stream: summer SEM survey sampled on 5 March 2018

Taxa List	Site Code	MCI score	KTK000150	KTK000248
	Sample Number		FWB18141	FWB18142
NEMERTEA	Nemertea	3	-	C
ANNELIDA (WORMS)	Oligochaeta	1	R	A
MOLLUSCA	*Potamopyrgus*	4	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C
	Coloburiscus	7	A	R
	Deleatidium	8	A	C
	Nesameletus	9	C	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-
	Stenoperla	10	R	-
	Zelandobius	5	R	-
	Zelandobius illiesi	10	R	-
	Zelandoperla	8	A	-
COLEOPTERA (BEETLES)	Elmidae	6	-	VA
	Hydraenidae	8	R	R
	Staphylinidae	5	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	A
	Hydrobiosis	5	-	C
	Hydrobiosella	9	C	-
	Neurochorema	6	-	R
	Hydropsyche (Orthopsyche)	9	C	-
	Beraeoptera	8	R	-
	Pycnocentria	7	R	-
	Pycnocentrodes	5	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A
	Eriopterini	5	R	-
	Maoridiamesa	3	-	R
	Orthocladiinae	2	A	VA
	Polypedilum	3	C	-
	Tanytarsini	3	-	A
	Empididae	3	-	R
	Austrosimulium	3	R	R
		No of taxa	22	19
		MCI	132	95
		SQMCI	6.6	4.0
		EPT (taxa)	13	7
		%EPT (taxa)	59	37
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 79 Macroinvertebrate fauna of the Kaupokonui River: spring SEM survey sampled on 31 October 2017

Taxa List	Site Code	MCI score	KPK000250	KPK000500	KPK000990	KPK000660	KPK000880
	Sample Number		FWB17389	FWB17390	FWB17391	FWB17395	FWB17398
ANNELIDA (WORMS)	Oligochaeta	1	-	-	A	R	R
	Lumbricidae	5	-	-	-	-	R
MOLLUSCA	*Potamopyrgus*	4	-	-	C	-	-
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	R	-	-	-	-
	Austroclima	7	-	C	A	R	R
	Coloburiscus	7	A	XA	R	VA	R
	Deleatidium	8	XA	XA	VA	XA	XA
	Nesameletus	9	A	A	-	C	-
	Zephlebia group	7	-	-	-	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	C	R	-	-
	Megaleptoperla	9	C	R	-	-	-
	Stenoperla	10	C	R	-	-	-
	Zelandobius	5	A	C	R	C	-
	Zelandoperla	8	A	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	C	A	C
	Hydraenidae	8	C	C	-	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	-	C	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A	VA	C	A
	Costachorema	7	R	R	C	C	C
	Hydrobiosis	5	-	R	R	-	C
	Hydrobiosella	9	R	-	-	-	-
	Hydrochorema	9	R	-	-	-	-
	Plectrocnemia	8	-	R	-	-	-
	Beraeoptera	8	VA	XA	R	VA	-
	Helicopsyche	10	VA	-	-	-	-
	Olinga	9	A	C	R	C	-
	Pycnocentria	7	-	-	R	-	-
	Pycnocentrodes	5	C	XA	VA	XA	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	C	C	A
	Eriopterini	5	C	R	-	R	-
	Maoridiamesa	3	C	R	VA	R	XA
	Orthocladiinae	2	R	C	A	-	VA
	Polypedilum	3	R	-	-	-	-
	Tanypodinae	5	R	-	-	-	-
	Tanytarsini	3	-	-	C	-	R
	Empididae	3	R	-	-	-	-
	Muscidae	3	-	-	R	-	-
	Austrosimulium	3	-	-	R	R	-
	Tabanidae	3	-	R	-	-	-
ACARINA (MITES)	Acarina	5	-	-	-	R	R
		No of taxa	27	24	21	20	15
		MCI	132	128	102	119	97
		SQMCI	8.0	6.9	4.8	6.6	5.2
		EPT (taxa)	17	16	12	11	7
		%EPT (taxa)	63	67	57	55	47
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa					

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

Table 80 Macroinvertebrate fauna of the Kaupokonui Stream: summer SEM survey sampled on 1 March 2018

Taxa List	Site Code	MCI score	KPK000250	KPK000500	KPK000660	KPK000880
	Sample Number		FWB18099	FWB18100	FWB18114	FWB18117
NEMERTEA	Nemertea	3	-	-	C	A
NEMATODA	Nematoda	3	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R	C
	Lumbricidae	5	-	-	R	-
MOLLUSCA	*Latia*	5	-	-	-	R
	Potamopyrgus	4	-	R	A	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	A	C	R
	Coloburiscus	7	A	VA	A	-
	Deleatidium	8	VA	XA	XA	C
	Nesameletus	9	R	VA	R	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-	R	-
	Megaleptoperla	9	C	C	-	-
	Stenoperla	10	R	-	-	-
	Zelandoperla	8	A	R	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	VA	VA	A
	Hydraenidae	8	C	C	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	A	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	VA	VA	VA
	Costachorema	7	R	R	C	-
	Hydrobiosis	5	-	A	C	C
	Plectrocnemia	8	-	R	-	-
	Psilochorema	6	C	-	-	-
	Beraeoptera	8	R	A	C	-
	Helicopsyche	10	R	R	-	-
	Olinga	9	A	C	C	-
	Pycnocentrodes	5	-	A	C	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	VA	C	C
	Eriopterini	5	R	R	-	-
	Maoridiamesa	3	R	R	R	-
	Orthocladiinae	2	C	A	A	VA
	Polypedilum	3	R	-	-	-
	Tanypodinae	5	-	-	R	-
	Tanytarsini	3	-	-	R	A
	Empididae	3	R	-	-	-
	Muscidae	3	-	R	-	R
	Austrosimulium	3	-	R	R	-
	Tanyderidae	4	-	R	-	-
		No of taxa	22	25	25	16
		MCI	133	123	113	89
		SQMCI	7.2	7.0	6.9	3.5
		EPT (taxa)	13	14	12	5
		%EPT (taxa)	59	56	48	31
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa				

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

Table 81 Macroinvertebrate fauna of the Kurapete Stream: spring SEM survey sampled on 26 October 2017

Taxa List	Site Code	MCI score	KRP000300	KRP000660
	Sample Number		FWB17357	FWB17360
ANNELIDA (WORMS)	Oligochaeta	1	VA	C
MOLLUSCA	*Potamopyrgus*	4	-	R
CRUSTACEA	Paraleptamphopidae	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	VA
	Coloburiscus	7	-	A
	Deleatidium	8	C	VA
	Zephlebia group	7	A	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-
	Zelandobius	5	-	C
COLEOPTERA (BEETLES)	Elmidae	6	C	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	C
	Costachorema	7	-	C
	Hydrobiosis	5	R	R
	Hydrobiosella	9	-	R
	Pycnocentria	7	-	R
	Pycnocentrodes	5	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A
	Eriopterini	5	R	-
	Maoridiamesa	3	-	R
	Orthocladiinae	2	A	A
	Polypedilum	3	R	R
	Tanypodinae	5	-	R
	Tanytarsini	3	-	R
	Empididae	3	-	R
	Austrosimulium	3	A	C
		No of taxa	14	24
		MCI	97	101
		SQMCI	3.0	6.5
		EPT (taxa)	6	11
		%EPT (taxa)	43	46
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 82 Macroinvertebrate fauna of the Kurapete Stream: spring SEM survey sampled on 25 October 2017

Taxa List	Site Code	MCI	MKW000200	MKW000300
	Sample Number	score	FWB17334	FWB17335
ANNELIDA (WORMS)	Lumbricidae	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-
	Coloburiscus	7	C	A
	Deleatidium	8	XA	XA
	Nesameletus	9	C	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R
	Austroperla	9	-	R
	Megaleptoperla	9	R	R
	Stenoperla	10	R	-
	Zelandobius	5	R	-
	Zelandoperla	8	A	C
COLEOPTERA (BEETLES)	Elmidae	6	A	C
	Hydraenidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	C	C
	Hydrobiosis	5	C	-
	Hydrochorema	9	R	-
	Plectrocnemia	8	R	-
	Psilochorema	6	R	C
	Beraeoptera	8	VA	C
	Olinga	9	-	R
	Pycnocentrodes	5	R	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	R	-
	Maoridiamesa	3	C	R
	Orthocladiinae	2	R	C
	Tanytarsini	3	-	R
	Austrosimulium	3	R	-
		No of taxa	23	19
		MCI	131	127
		SQMCI	7.8	7.7
		EPT (taxa)	16	12
		%EPT (taxa)	70	63
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 83 Macroinvertebrate fauna of the Maketawa Stream: spring SEM survey sampled on 25 October 2017

Taxa List	Site Code / Sample Number	MCI score	MKW000200 FWB17083	MKW000300 FWB17084
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	-	C
	Deleatidium	8	XA	XA
	Nesameletus	9	A	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	-	R
	Megaleptoperla	9	C	R
	Stenoperla	10	R	-
	Zelandoperla	8	A	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
	Hydraenidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	A
	Costachorema	7	A	C
	Hydrobiosis	5	C	R
	Hydropsyche (Orthopsyche)	9	R	-
	Plectrocnemia	8	R	-
	Psilochorema	6	R	R
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A
	Maoridiamesa	3	-	R
	Orthocladiinae	2	R	C
	Polypedilum	3	-	R
	Tanytarsini	3	-	R
	Empididae	3	-	R
	Austrosimulium	3	-	C
		No of taxa	13	20
		MCI	142	112
		SQMCI	7.7	7.5
		EPT (taxa)	10	10
		%EPT (taxa)	77	50
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 84 Macroinvertebrate fauna of the Maketawa Stream: summer SEM survey sampled on 6 March 2018

Taxa List	Site Code	MCI score	KRP000300	KRP000660
	Sample Number		FWB18146	FWB18147
NEMERTEA	Nemertea	3	C	-
ANNELIDA (WORMS)	Oligochaeta	1	C	VA
MOLLUSCA	*Potamopyrgus*	4	A	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A
	Coloburiscus	7	C	C
	Deleatidium	8	R	C
	Zephlebia group	7	A	R
COLEOPTERA (BEETLES)	Elmidae	6	R	VA
	Ptilodactylidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	A
	Hydrobiosis	5	-	R
	Neurochorema	6	-	C
	Oxyethira	2	-	C
	Pycnocentria	7	R	C
	Pycnocentrodes	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	A
	Orthocladiinae	2	-	A
	Tanytarsini	3	-	A
	Empididae	3	-	C
	Muscidae	3	-	R
	Austrosimulium	3	C	R
		No of taxa	12	21
		MCI	107	98
		SQMCI	5.2	4.0
		EPT (taxa)	6	9
		%EPT (taxa)	50	43
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 85 Macroinvertebrate fauna of the Mangaehu River: spring SEM survey sampled on 9 October 2017 and summer SEM survey sampled on 15 February 2018

Taxa List	Site Code	MCI score	MGH000950	MGH000950
	Sample Number		FWB17284	FWB18061
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	R	A
MOLLUSCA	*Potamopyrgus*	4	-	A
CRUSTACEA	*Paracalliope*	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A
	Coloburiscus	7	R	A
	Deleatidium	8	C	C
	Zephlebia group	7	C	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	-
	Zelandobius	5	C	-
COLEOPTERA (BEETLES)	Elmidae	6	-	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A
	Costachorema	7	C	-
	Hydrobiosis	5	C	C
	Oxyethira	2	-	R
	Pycnocentria	7	R	R
	Pycnocentrodes	5	A	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	A
	Maoridiamesa	3	C	-
	Orthocladiinae	2	A	A
	Polypedilum	3	-	C
	Tanytarsini	3	-	A
	Empididae	3	-	R
	Muscidae	3	-	C
		No of taxa	16	20
		MCI	104	92
		SQMCI	5.0	4.6
		EPT (taxa)	11	8
		%EPT (taxa)	69	40
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 86 Macroinvertebrate fauna of the Manganui River: spring SEM survey sampled on 25 October 2017

Taxa List	Site Code	MCI score	MGN000195	MGN000427
	Sample Number		FWB17336	FWB17337
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	-
	Coloburiscus	7	C	R
	Deleatidium	8	XA	XA
	Nesameletus	9	A	R
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	-	R
	Zelandoperla	8	A	-
COLEOPTERA (BEETLES)	Elmidae	6	A	R
	Hydrophilidae	5	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	R
	Costachorema	7	-	C
	Hydrobiosis	5	C	R
	Hydrobiosella	9	R	-
	Beraeoptera	8	C	R
	Olinga	9	R	-
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A
	Eriopterini	5	C	-
	Maoridiamesa	3	-	C
	Orthocladiinae	2	R	A
	Tanytarsini	3	-	R
	Austrosimulium	3	R	-
ACARINA (MITES)	Acarina	5	R	-
		No of taxa	16	15
		MCI	126	117
		SQMCI	7.9	7.6
		EPT (taxa)	9	9
		%EPT (taxa)	56	60
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 87 Macroinvertebrate fauna of the Manganui River: summer SEM survey sampled on 6 March 2018

Taxa List	Site Code	MCI score	MGN000195	MGN000427
	Sample Number		FWB18156	FWB18157
NEMERTEA	Nemertea	3	-	C
ANNELIDA (WORMS)	Oligochaeta	1	-	C
	Lumbricidae	5	-	R
MOLLUSCA	*Potamopyrgus*	4	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C
	Coloburiscus	7	A	R
	Deleatidium	8	VA	A
	Nesameletus	9	VA	-
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	R	-
	Zelandoperla	8	C	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	XA
	Costachorema	7	-	R
	Hydrobiosis	5	R	A
	Neurochorema	6	-	A
	Psilochorema	6	C	-
	Beraeoptera	8	C	-
	Confluens	5	R	-
	Olinga	9	R	-
	Oxyethira	2	-	R
	Pycnocentrodes	5	A	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A
	Eriopterini	5	C	-
	Maoridiamesa	3	R	R
	Orthocladiinae	2	C	VA
	Tanytarsini	3	-	VA
	Empididae	3	-	C
	Muscidae	3	-	R
	Austrosimulium	3	R	-
	Tanyderidae	4	-	R
		No of taxa	20	22
		MCI	121	91
		SQMCI	7.2	4.1
		EPT (taxa)	13	8
		%EPT (taxa)	65	36
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 88 Macroinvertebrate fauna of the Mangaoraka Stream: spring SEM survey sampled on 25 October 2017; summer SEM survey sampled on 28 February 2018

Taxa List	Site Code	MCI score	MRK000420	MRK000420
	Sample Number		FWB17322	FWB18092
NEMERTEA	Nemertea	3	-	A
ANNELIDA (WORMS)	Oligochaeta	1	A	A
MOLLUSCA	*Potamopyrgus*	4	-	VA
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	A
	Coloburiscus	7	R	-
	Deleatidium	8	A	-
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C	R
COLEOPTERA (BEETLES)	Elmidae	6	C	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A
	Costachorema	7	C	-
	Hydrobiosis	5	-	C
	Neurochorema	6	R	C
	Oxyethira	2	-	C
	Pycnocentria	7	R	R
	Pycnocentrodes	5	A	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	-
	Maoridiamesa	3	C	-
	Orthocladiinae	2	VA	VA
	Polypedilum	3	R	-
	Tanytarsini	3	C	VA
	Empididae	3	R	C
	Muscidae	3	-	R
	Austrosimulium	3	R	C
		No of taxa	19	18
		MCI	97	84
		SQMCI	3.9	3.9
		EPT (taxa)	9	7
		%EPT (taxa)	47	39
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 89 Macroinvertebrate fauna of the Mangati Stream: spring SEM survey sampled on 1 March 2017

Taxa List	Site Code	MCI score	MGT000488	MGT000520
	Sample Number		FWB17347	FWB17353
NEMERTEA	Nemertea	3	R	-
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	A	VA
	Lumbricidae	5	C	-
MOLLUSCA	*Potamopyrgus*	4	C	R
CRUSTACEA	Ostracoda	1	R	-
	Paracalliope	5	A	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	-
	Psilochorema	6	R	-
	Triplectides	5	R	-
DIPTERA (TRUE FLIES)	Orthocladiinae	2	A	A
	Polypedilum	3	A	C
	Empididae	3	-	R
	Austrosimulium	3	C	-
		No of taxa	14	5
		MCI	76	52
		SQMCI	3.7	1.3
		EPT (taxa)	4	0
		%EPT (taxa)	29	0
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 90 Macroinvertebrate fauna of the Mangati Stream: summer SEM survey sampled on 1 March 2017

Taxa List	Site Code	MCI score	MGT000488	MGT000520
	Sample Number		FWB18083	FWB18089
NEMERTEA	Nemertea	3	C	C
ANNELIDA (WORMS)	Oligochaeta	1	VA	VA
	Lumbricidae	5	R	R
MOLLUSCA	*Potamopyrgus*	4	XA	XA
CRUSTACEA	Ostracoda	1	R	-
	Isopoda	5	-	R
	Paracalliope	5	XA	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	-
TRICHOPTERA (CADDISFLIES)	*Triplectides*	5	R	C
DIPTERA (TRUE FLIES)	*Limonia*	6	-	R
	Chironomus	1	C	-
	Orthocladiinae	2	R	C
	Austrosimulium	3	-	R
	Tanyderidae	4	-	C
ACARINA (MITES)	Acarina	5	R	-
		No of taxa	11	10
		MCI	71	76
		SQMCI	4.2	3.5
		EPT (taxa)	2	1
		%EPT (taxa)	18	10
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 91 Macroinvertebrate fauna of the Mangawhero Stream: spring SEM survey sampled on 6 November 2017

Taxa List	Site Code	MCI score	MWH000380	MWH000490
	Sample Number		FWB17412	FWB17413
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	C	A
	Lumbricidae	5	R	-
MOLLUSCA	*Potamopyrgus*	4	C	R
CRUSTACEA	*Paracalliope*	5	C	R
	Talitridae	5	-	C
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	R	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	C
	Costachorema	7	-	R
	Hydrobiosis	5	C	-
	Pycnocentria	7	-	R
	Pycnocentrodes	5	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	A
	Chironomus	1	R	-
	Maoridiamesa	3	C	VA
	Orthocladiinae	2	A	A
	Polypedilum	3	R	R
	Tanytarsini	3	-	R
	Austrosimulium	3	R	R
		No of taxa	13	16
		MCI	72	88
		SQMCI	3.0	3.2
		EPT (taxa)	3	6
		%EPT (taxa)	23	38
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 92 Macroinvertebrate fauna of the Mangawhero Stream: summer SEM survey sampled on 21 March 2018

Taxa List	Site Code	MCI score	MWH000380	MWH000490
	Sample Number		FWB18179	FWB18180
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R	R
NEMERTEA	Nemertea	3	C	A
NEMATODA	Nematoda	3	R	R
ANNELIDA (WORMS)	Oligochaeta	1	A	R
	Lumbricidae	5	C	R
MOLLUSCA	*Potamopyrgus*	4	A	A
	Sphaeriidae	3	R	-
CRUSTACEA	Ostracoda	1	C	-
	Paracalliope	5	R	A
EPHEMEROPTERA (MAYFLIES)	*Deleatidium*	8	-	C
COLEOPTERA (BEETLES)	Elmidae	6	-	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	A
	Hydrobiosis	5	R	C
	Oxyethira	2	A	-
	Pycnocentria	7	-	R
	Pycnocentrodes	5	-	R
	Triplectides	5	-	R
DIPTERA (TRUE FLIES)	*Limonia*	6	R	-
	Chironomus	1	C	-
	Harrisius	6	-	R
	Maoridiamesa	3	-	R
	Orthocladiinae	2	A	VA
	Tanytarsini	3	-	A
	Muscidae	3	R	C
	Austrosimulium	3	C	C
		No of taxa	17	21
		MCI	64	87
		SQMCI	2.5	3.4
		EPT (taxa)	2	6
		%EPT (taxa)	12	29
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 93 Macroinvertebrate fauna of the Mangorei Stream: spring 25 October 2017 summer SEM survey sampled on 2 March 2018

Taxa List	Site Code	MCI score	MGE000970	MGE000970
	Sample Number		FWB17333	FWB18138
NEMERTEA	Nemertea	3	-	C
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	R	C
MOLLUSCA	*Potamopyrgus*	4	-	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	A
	Coloburiscus	7	A	C
	Deleatidium	8	XA	A
	Zephlebia group	7	R	-
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	A	-
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	R	VA
	Hydraenidae	8	R	R
	Ptilodactylidae	8	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	VA
	Costachorema	7	C	-
	Hydrobiosis	5	R	C
	Neurochorema	6	C	C
	Beraeoptera	8	R	-
	Oxyethira	2	-	R
	Pycnocentrodes	5	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	A
	Eriopterini	5	-	R
	Harrisius	6	-	R
	Maoridiamesa	3	C	-
	Orthocladiinae	2	A	A
	Tanytarsini	3	C	VA
	Empididae	3	R	C
	Muscidae	3	-	R
	Austrosimulium	3	C	A
		No of taxa	23	22
		MCI	105	96
		SQMCI	7.0	4.6
		EPT (taxa)	12	6
		%EPT (taxa)	52	27
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 94 Macroinvertebrate fauna of the Patea River: spring SEM survey sampled on 30 October 2017

Taxa List	Site Code	MCI score	PAT000200	PAT000315	PAT000360
	Sample Number		FWB17361	FWB17362	FWB17365
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	C	R
	Coloburiscus	7	A	VA	A
	Deleatidium	8	VA	VA	VA
	Nesameletus	9	R	C	R
	Zephlebia group	7	-	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R	-
	Austroperla	9	C	-	-
	Megaleptoperla	9	C	-	-
	Stenoperla	10	R	-	-
	Zelandobius	5	A	R	R
	Zelandoperla	8	C	A	-
COLEOPTERA (BEETLES)	Elmidae	6	C	C	C
	Hydraenidae	8	R	C	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	C	C
	Costachorema	7	R	R	R
	Hydrobiosis	5	R	-	R
	Hydrobiosella	9	R	-	-
	Hydropsyche (Orthopsyche)	9	C	-	-
	Plectrocnemia	8	-	R	-
	Beraeoptera	8	A	VA	-
	Confluens	5	R	-	-
	Helicopsyche	10	C	-	-
	Olinga	9	R	R	R
	Pycnocentria	7	C	-	-
	Pycnocentrodes	5	-	C	C
	Zelolessica	7	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A	A
	Eriopterini	5	-	R	-
	Maoridiamesa	3	-	-	VA
	Orthocladiinae	2	C	R	VA
	Polypedilum	3	R	-	-
	Tanypodinae	5	-	R	-
	Empididae	3	R	-	-
	Austrosimulium	3	-	-	R
		No of taxa	27	21	18
		MCI	139	129	112
		SQMCI	7.4	7.4	4.6
		EPT (taxa)	20	14	10
		%EPT (taxa)	74	67	56
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

Table 95 Macroinvertebrate fauna of the Patea River: summer SEM survey sampled on 3 April 2018

Taxa List	Site Code	MCI score	PAT000200	PAT000315	PAT000360
	Sample Number		FWB18189	FWB18190	FWB18195
NEMATODA	Nematoda	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	R	VA
MOLLUSCA	*Potamopyrgus*	4	-	R	C
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-	-
	Austroclima	7	C	C	C
	Coloburiscus	7	VA	XA	C
	Deleatidium	8	VA	XA	A
	Nesameletus	9	C	C	-
	Zephlebia group	7	R	R	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	R	-
	Megaleptoperla	9	C	-	-
	Zelandobius	5	C	-	-
	Zelandoperla	8	A	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	C	C
	Hydraenidae	8	C	C	R
	Hydrophilidae	5	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	VA	VA
	Costachorema	7	-	R	R
	Hydrobiosis	5	C	C	A
	Neurochorema	6	-	-	R
	Hydropsyche (Orthopsyche)	9	A	-	-
	Beraeoptera	8	VA	C	R
	Confluens	5	C	C	R
	Helicopsyche	10	VA	-	-
	Olinga	9	C	-	-
	Oxyethira	2	-	-	R
	Pycnocentria	7	A	-	R
	Pycnocentrodes	5	-	C	A
	Zelolessica	7	A	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	A
	Maoridiamesa	3	-	-	A
	Orthocladiinae	2	R	C	VA
	Polypedilum	3	C	R	-
	Tanytarsini	3	-	C	VA
	Empididae	3	-	-	C
	Ephydridae	4	-	C	-
	Muscidae	3	-	-	C
	Austrosimulium	3	-	R	-
		No of taxa	25	24	24
		MCI	140	113	99
		SQMCI	7.8	7.1	3.2
		EPT (taxa)	18	13	11
		%EPT (taxa)	72	54	46
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

Table 96 Macroinvertebrate fauna of the Punehu Stream: spring SEM survey sampled on 19 October 2017

Taxa List	Site Code	MCI score	PNH000200	PNH000900
	Sample Number		FWB17295	FWB17296
ANNELIDA (WORMS)	Lumbricidae	5	-	R
MOLLUSCA	*Potamopyrgus*	4	R	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	C
	Coloburiscus	7	VA	C
	Deleatidium	8	XA	XA
	Nesameletus	9	A	C
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-
	Megaleptoperla	9	C	-
	Zelandobius	5	R	C
	Zelandoperla	8	A	-
COLEOPTERA (BEETLES)	Elmidae	6	A	C
	Hydraenidae	8	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	C
	Costachorema	7	C	C
	Hydrobiosis	5	R	R
	Hydropsyche (Orthopsyche)	9	R	-
	Plectrocnemia	8	R	-
	Psilochorema	6	R	-
	Beraeoptera	8	VA	C
	Helicopsyche	10	R	-
	Olinga	9	R	-
	Pycnocentrodes	5	C	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	R
	Eriopterini	5	C	-
	Chironomus	1	-	R
	Maoridiamesa	3	C	C
	Orthocladiinae	2	C	C
	Austrosimulium	3	-	R
		No of taxa	25	20
		MCI	130	109
		SQMCI	7.7	7.3
		EPT (taxa)	17	10
		%EPT (taxa)	68	50
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 97 Macroinvertebrate fauna of the Punehu Stream: summer SEM survey sampled on 14 March 2018

Taxa List	Site Code	MCI score	PNH000200	PNH000900
	Sample Number		FWB18059	FWB18060
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	R
NEMERTEA	Nemertea	3	R	C
ANNELIDA (WORMS)	Oligochaeta	1	-	VA
	Lumbricidae	5	R	R
MOLLUSCA	*Potamopyrgus*	4	R	A
CRUSTACEA	*Paranephrops*	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	R	-
	Austroclima	7	R	A
	Coloburiscus	7	A	A
	Deleatidium	8	XA	VA
	Ichthybotus	8	R	-
	Nesameletus	9	VA	-
	Zephlebia group	7	-	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	-
	Megaleptoperla	9	C	-
	Stenoperla	10	R	-
	Zelandoperla	8	C	-
COLEOPTERA (BEETLES)	Elmidae	6	XA	A
	Hydraenidae	8	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	VA
	Costachorema	7	R	-
	Hydrobiosis	5	A	C
	Neurochorema	6	R	-
	Polyplectropus	6	C	-
	Psilochorema	6	R	-
	Beraeoptera	8	A	-
	Olinga	9	C	-
	Oxyethira	2	R	-
	Pycnocentrodes	5	VA	XA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	C	-
	Orthocladiinae	2	R	C
	Polypedilum	3	-	VA
	Tanytarsini	3	-	R
	Muscidae	3	R	R
	Austrosimulium	3	-	C
	Tabanidae	3	R	-
	Tanyderidae	4	-	R
		No of taxa	32	21
		MCI	124	90
		SQMCI	6.8	4.7
		EPT (taxa)	19	7
		%EPT (taxa)	59	33
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 98 Macroinvertebrate fauna of the Tangahoe River: spring SEM survey sampled on 1 November 2017

Taxa List	Site Code	MCI score	TNH000090	TNH000200	TNH000515
	Sample Number		FWB17400	FWB17401	FWB17402
ANNELIDA (WORMS)	Oligochaeta	1	R	-	C
	Lumbricidae	5	-	-	R
MOLLUSCA	*Latia*	5	-	R	C
	Potamopyrgus	4	R	R	A
CRUSTACEA	*Phreatogammarus*	5	-	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A	C
	Coloburiscus	7	-	C	R
	Deleatidium	8	VA	VA	C
	Neozephlebia	7	R	-	-
	Zephlebia group	7	C	C	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	A	-
	Spaniocerca	8	R	-	-
	Zelandobius	5	-	C	C
COLEOPTERA (BEETLES)	Elmidae	6	R	A	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	R	-
	Costachorema	7	R	-	R
	Hydrobiosis	5	R	R	R
	Hydropsyche (Orthopsyche)	9	-	R	-
	Hudsonema	6	-	-	C
	Pycnocentrodes	5	-	R	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	R	R
	Eriopterini	5	R	-	-
	Maoridiamesa	3	-	-	R
	Orthocladiinae	2	R	R	A
	Polypedilum	3	-	-	C
	Tanytarsini	3	-	-	C
	Ephydridae	4	-	-	R
	Austrosimulium	3	A	R	R
		No of taxa	14	17	21
		MCI	107	111	94
		SQMCI	6.9	7.0	5.0
		EPT (taxa)	8	10	8
		%EPT (taxa)	57	59	38
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

Table 99 Macroinvertebrate fauna of the Tangahoe River: summer SEM survey sampled on 16 February 2018

Taxa List	Site Code	MCI score	TNH000090	TNH000200	TNH000515
	Sample Number		FWB18063	FWB18064	FWB18065
NEMERTEA	Nemertea	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	C	C	C
	Lumbricidae	5	-	-	R
MOLLUSCA	*Latia*	5	-	-	R
	Potamopyrgus	4	C	VA	C
CRUSTACEA	*Phreatogammarus*	5	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	VA	R
	Coloburiscus	7	-	C	-
	Deleatidium	8	A	A	-
	Nesameletus	9	-	R	-
	Zephlebia group	7	A	A	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	-	R	-
	Zelandobius	5	-	R	-
ODONATA (DRAGONFLIES)	*Antipodochlora*	5	-	R	-
COLEOPTERA (BEETLES)	Elmidae	6	C	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A	XA
	Hydrobiosis	5	R	C	R
	Psilochorema	6	R	-	-
	Olinga	9	-	R	-
	Oxyethira	2	-	R	-
	Pycnocentrodes	5	-	A	A
	Triplectides	5	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	A	C
	Eriopterini	5	R	R	-
	Harrisius	6	-	R	-
	Maoridiamesa	3	-	-	R
	Orthocladiinae	2	R	R	C
	Polypedilum	3	-	-	C
	Tanypodinae	5	R	-	-
	Tanytarsini	3	R	C	R
	Muscidae	3	-	R	-
	Austrosimulium	3	C	R	-
	Tanyderidae	4	R	R	-
		No of taxa	18	25	17
		MCI	97	102	86
		SQMCI	6.1	5.6	4.3
		EPT (taxa)	7	11	4
		%EPT (taxa)	39	44	24
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

Table 100 Macroinvertebrate fauna of the Timaru Stream: spring SEM survey sampled on 30 October 2017

Taxa List	Site Code	MCI score	TMR000150	TMR000375
	Sample Number		FWB17374	FWB17375
ANNELIDA (WORMS)	Oligochaeta	1	-	C
MOLLUSCA	*Potamopyrgus*	4	-	R
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	R	-
	Ameletopsis	10	C	-
	Austroclima	7	C	A
	Coloburiscus	7	A	A
	Deleatidium	8	XA	VA
	Ichthybotus	8	-	R
	Nesameletus	9	A	R
	Zephlebia group	7	-	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	R
	Austroperla	9	R	-
	Megaleptoperla	9	C	-
	Stenoperla	10	C	-
	Zelandobius	5	A	A
	Zelandoperla	8	C	C
COLEOPTERA (BEETLES)	Elmidae	6	A	A
	Hydraenidae	8	C	R
	Hydrophilidae	5	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	A
	Costachorema	7	C	C
	Hydrobiosis	5	-	R
	Neurochorema	6	-	C
	Hydropsyche (Orthopsyche)	9	R	-
	Beraeoptera	8	A	VA
	Confluens	5	-	C
	Helicopsyche	10	A	-
	Olinga	9	C	R
	Oxyethira	2	-	R
	Pycnocentrodes	5	C	VA
	Zelolessica	7	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A
	Eriopterini	5	-	R
	Hexatomini	5	R	-
	Maoridiamesa	3	A	C
	Orthocladiinae	2	C	VA
	Polypedilum	3	-	R
	Tanytarsini	3	-	R
	Empididae	3	-	R
	Austrosimulium	3	-	R
		No of taxa	28	31
		MCI	140	108
		SQMCI	7.7	5.7
		EPT (taxa)	20	17
		%EPT (taxa)	71	55
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 101 Macroinvertebrate fauna of the Timaru Stream: summer SEM survey sampled on 28 February 2018

Taxa List	Site Code	MCI score	TMR000150	TMR000375
	Sample Number		FWB18095	FWB18096
NEMERTEA	Nemertea	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	C
MOLLUSCA	*Potamopyrgus*	4	R	A
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	R	-
	Ameletopsis	10	C	-
	Austroclima	7	C	A
	Coloburiscus	7	A	A
	Deleatidium	8	VA	R
	Nesameletus	9	C	-
	Zephlebia group	7	C	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-
	Megaleptoperla	9	C	-
	Stenoperla	10	C	-
	Taraperla	10	R	-
	Zelandobius	5	C	-
	Zelandoperla	8	C	R
COLEOPTERA (BEETLES)	Elmidae	6	C	A
	Hydraenidae	8	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	VA
	Costachorema	7	R	-
	Hydrobiosis	5	R	R
	Neurochorema	6	R	C
	Hydropsyche (Orthopsyche)	9	R	-
	Psilochorema	6	R	-
	Alloecentrella	8	R	-
	Beraeoptera	8	A	R
	Olinga	9	C	R
	Oxyethira	2	C	A
	Pycnocentria	7	C	R
	Pycnocentrodes	5	-	XA
	Triplectides	5	R	R
	Zelolessica	7	C	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A
	Harrisius	6	R	R
	Maoridiamesa	3	-	R
	Orthocladiinae	2	A	A
	Polypedilum	3	C	-
	Tanytarsini	3	-	A
	Empididae	3	-	C
	Muscidae	3	-	R
	Austrosimulium	3	-	C
	Tanyderidae	4	-	R
		No of taxa	34	28
		MCI	136	101
		SQMCI	6.9	4.8
		EPT (taxa)	25	12
		%EPT (taxa)	74	43
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 102 Macroinvertebrate fauna of the Waiau Stream: spring SEM survey sampled on 25 October 2017 and summer SEM survey sampled 28 February 2018

Taxa List	Site Code	MCI score	WAI000110	WAI000110
	Sample Number		FWB17323	FWB18091
NEMERTEA	Nemertea	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	A	VA
MOLLUSCA	*Latia*	5	C	C
	Lymnaeidae	3	-	R
	Physa	3	-	C
	Potamopyrgus	4	C	C
CRUSTACEA	Ostracoda	1	-	R
	Paracalliope	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	A
	Coloburiscus	7	R	-
	Deleatidium	8	C	-
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	A	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	VA
	Hydrobiosis	5	C	C
	Neurochorema	6	-	R
	Psilochorema	6	R	-
	Hudsonema	6	-	C
	Oxyethira	2	-	A
	Paroxyethira	2	-	R
	Pycnocentria	7	A	VA
	Pycnocentrodes	5	VA	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	C
	Chironomus	1	-	R
	Harrisius	6	R	-
	Maoridiamesa	3	C	-
	Orthocladiinae	2	A	VA
	Tanytarsini	3	-	C
	Muscidae	3	-	R
	Austrosimulium	3	R	C
ACARINA (MITES)	Acarina	5	R	C
		No of taxa	21	25
		MCI	101	79
		SQMCI	5.4	4.3
		EPT (taxa)	9	7
		%EPT (taxa)	43	28
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 103 Macroinvertebrate fauna of the Waimoku Stream: Spring SEM survey sampled on 30 October 2017

Taxa List	Site Code	MCI score	WMK000100	WMK000298
	Sample Number		FWB17372	FWB17373
NEMATOMORPHA	Nematomorpha	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	-	A
	Lumbricidae	5	R	-
MOLLUSCA	*Potamopyrgus*	4	R	XA
CRUSTACEA	Talitridae	5	C	-
	Paranephrops	5	C	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	A
	Coloburiscus	7	VA	A
	Deleatidium	8	C	C
	Ichthybotus	8	R	-
	Nesameletus	9	R	-
	Zephlebia group	7	A	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	A	-
	Spaniocerca	8	R	-
	Stenoperla	10	R	-
	Zelandobius	5	C	-
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	C	C
	Hydraenidae	8	R	-
	Ptilodactylidae	8	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	R
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	-	C
	Hydrobiosis	5	R	C
	Hydrobiosella	9	C	-
	Hydropsyche (Orthopsyche)	9	VA	-
	Pycnocentria	7	C	R
	Pycnocentrodes	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	C
	Eriopterini	5	R	-
	Hexatomini	5	R	-
	Maoridiamesa	3	-	C
	Orthocladiinae	2	C	VA
	Polypedilum	3	C	R
	Empididae	3	R	-
	Austrosimulium	3	-	C
	Tanyderidae	4	-	R
		No of taxa	29	18
		MCI	128	101
		SQMCI	7.4	3.9
		EPT (taxa)	15	8
		%EPT (taxa)	52	44
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 104 Macroinvertebrate fauna of the Waimoku Stream: summer SEM survey sampled on 28 February 2018

Taxa List	Site Code	MCI score	WMK000100	WMK000298
	Sample Number		FWB18097	FWB18098
ANNELIDA (WORMS)	Oligochaeta	1	R	C
MOLLUSCA	*Latia*	5	-	R
	Potamopyrgus	4	C	XA
	Sphaeriidae	3	-	R
CRUSTACEA	Isopoda	5	-	R
	Paraleptamphopidae	5	R	-
	Talitridae	5	C	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	C
	Coloburiscus	7	VA	R
	Deleatidium	8	C	-
	Nesameletus	9	C	-
	Zephlebia group	7	A	C
PLECOPTERA (STONEFLIES)	*Austroperla*	9	A	-
	Megaleptoperla	9	C	-
	Stenoperla	10	C	-
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A
	Hydraenidae	8	C	-
	Hydrophilidae	5	R	-
	Ptilodactylidae	8	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	R
TRICHOPTERA (CADDISFLIES)	Ecnomidae/Psychomyiidae	6	-	R
	Hydrobiosella	9	A	-
	Hydrochorema	9	R	-
	Hydropsyche (Orthopsyche)	9	VA	-
	Plectrocnemia	8	R	-
	Psilochorema	6	R	-
	Oxyethira	2	-	R
	Pycnocentria	7	C	C
	Pycnocentrodes	5	-	C
	Triplectides	5	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	-
	Eriopterini	5	R	-
	Hexatomini	5	R	-
	Harrisius	6	R	-
	Orthocladiinae	2	C	R
	Polypedilum	3	A	C
	Tanytarsini	3	R	-
	Nothodixa	4	R	-
	Empididae	3	R	-
	Austrosimulium	3	-	R
		No of taxa	33	18
		MCI	125	94
		SQMCI	7.3	4.2
		EPT (taxa)	15	7
		%EPT (taxa)	45	39
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 105 Macroinvertebrate fauna of the Waingongoro River: spring SEM survey sampled on 6 November 2017

Taxa List	Site Code	MCI score	WGG000115	WGG000150	WGG000500	WGG000665	WGG000895	WGG000995
	Sample Number		FWB17404	FWB17405	FWB17406	FWB17409	FWB17410	FWB17411
NEMERTEA	Nemertea	3	-	-	-	-	R	-
NEMATODA	Nematoda	3	-	-	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	R	R	-	R	A	A
	Lumbricidae	5	-	-	-	-	R	-
MOLLUSCA	*Potamopyrgus*	4	-	-	-	-	VA	R
CRUSTACEA	*Paracalliope*	5	-	-	-	-	C	-
	Paratya	3	-	-	-	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-	-	-	-	-
	Austroclima	7	R	C	-	R	A	R
	Coloburiscus	7	A	VA	VA	C	R	-
	Deleatidium	8	VA	VA	XA	XA	VA	A
	Neozephlebia	7	R	-	-	-	-	-
	Nesameletus	9	C	A	C	R	-	-
	Zephlebia group	7	-	R	-	R	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-	-	-	-	-
	Austroperla	9	R	C	-	-	-	-
	Megaleptoperla	9	C	C	R	-	-	-
	Stenoperla	10	R	-	-	-	-	-
	Zelandobius	5	R	-	R	R	C	C
	Zelandoperla	8	C	A	-	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	A	-	A	A
	Hydraenidae	8	C	C	-	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	R	R	R	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	C	A	A	A	C
	Costachorema	7	-	-	R	C	-	-
	Hydrobiosis	5	-	R	-	R	C	-
	Hydrobiosella	9	R	R	-	-	-	-
	Beraeoptera	8	A	VA	R	-	-	-
	Confluens	5	-	R	R	-	-	-
	Helicopsyche	10	A	A	-	-	-	-
	Olinga	9	A	A	-	-	-	-
	Pycnocentria	7	-	R	-	-	C	-
	Pycnocentrodes	5	-	C	A	R	VA	VA
	Triplectides	5	-	-	-	-	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C	R	R	R	C
	Eriopterini	5	R	C	R	-	-	-
	Chironomus	1	-	-	-	-	R	A
	Maoridiamesa	3	C	-	-	A	R	A
	Orthocladiinae	2	-	R	-	A	C	A
	Polypedilum	3	R	R	-	-	R	C
	Tanytarsini	3	-	-	-	R	-	-
	Empididae	3	R	-	-	-	-	-
	Ephydridae	4	-	-	-	R	-	C
	Austrosimulium	3	-	-	-	C	A	-
	Tanyderidae	4	-	-	R	R	R	-
		No of taxa	26	25	15	19	24	16
		MCI	135	130	125	101	93	80
		SQMCI	7.7	7.6	7.6	7.4	5.3	4.2
		EPT (taxa)	17	17	10	10	10	5
		%EPT (taxa)	65	68	67	53	42	31
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa						

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

Table 106 Macroinvertebrate fauna of the Waingongoro River: summer SEM survey sampled on 21 March 2018

Taxa List	Site Code	MCI score	WGG000115	WGG000150	WGG000500	WGG000665	WGG000895	WGG000995
	Sample Number		FWB18169	FWB18170	FWB18171	FWB18176	FWB18177	FWB18178
NEMERTEA	Nemertea	3	-	-	R	R	R	C
ANNELIDA (WORMS)	Oligochaeta	1	-	-	-	R	A	C
	Lumbricidae	5	-	-	-	-	C	-
HIRUDINEA (LEECHES)	Hirudinea	3	-	-	-	-	R	-
MOLLUSCA	*Latia*	5	-	-	-	-	R	-
	Potamopyrgus	4	-	-	C	R	VA	A
	Sphaeriidae	3	-	-	-	-	R	-
CRUSTACEA	Ostracoda	1	-	-	R	-	-	-
	Paracalliope	5	-	-	-	-	C	-
	Phreatogammarus	5	-	-	-	-	-	R
	Paratya	3	-	-	-	-	-	C
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-	-	-	-	-
	Austroclima	7	C	A	C	-	R	R
	Coloburiscus	7	VA	VA	A	R	-	-
	Deleatidium	8	VA	VA	XA	VA	R	-
	Nesameletus	9	VA	VA	R	-	-	-
	Zephlebia group	7	-	R	-	-	-	-
PLECOPTERA (STONEFLIES)	*Austroperla*	9	C	-	-	-	-	-
	Megaleptoperla	9	C	-	-	-	-	-
	Stenoperla	10	R	-	-	-	-	-
	Zelandobius	5	R	-	-	-	-	-
	Zelandoperla	8	VA	A	-	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	C	A	A	R	VA	A
	Hydraenidae	8	A	A	R	-	-	R
	Ptilodactylidae	8	-	R	-	-	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	A	C	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A	VA	A	A	VA
	Costachorema	7	-	R	R	-	-	-
	Hydrobiosis	5	R	R	C	R	C	R
	Neurochorema	6	-	-	-	-	R	-
	Hydropsyche (Orthopsyche)	9	C	-	-	-	-	-
	Beraeoptera	8	VA	A	R	-	-	-
	Helicopsyche	10	A	C	-	-	-	-
	Hudsonema	6	-	-	-	-	R	R
	Olinga	9	A	C	R	-	-	-
	Oxyethira	2	-	-	-	-	C	R
	Pycnocentria	7	-	-	R	-	A	C
	Pycnocentrodes	5	R	A	C	-	VA	A
	Triplectides	5	-	-	-	-	-	R
	Zelolessica	7	R	-	-	-	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	C	R	-	R
	Eriopterini	5	R	C	R	R	-	-
	Orthocladiinae	2	C	C	C	C	C	A
	Polypedilum	3	C	-	-	-	-	R
	Tanytarsini	3	R	-	R	C	A	A
	Ceratopogonidae	3	-	R	-	-	-	-
	Empididae	3	R	R	-	-	-	-
	Ephydridae	4	-	-	-	-	-	C
	Austrosimulium	3	-	R	R	R	C	C
	Tanyderidae	4	-	-	-	R	-	-
ACARINA (MITES)	Acarina	5	-	R	-	-	R	-
		No of taxa	27	24	22	15	23	22
		MCI	134	124	112	89	91	89
		SQMCI	7.8	7.3	7.1	6.8	4.7	4.0
		EPT (taxa)	18	13	11	4	8	7
		%EPT (taxa)	67	54	50	27	35	32
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa						

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

Table 107 Macroinvertebrate fauna of the Waiokura Stream: spring SEM survey sampled on 31 October 2017

Taxa List	Site Code	MCI score	WKR000500	WKR000700
	Sample Number		FWB17392	FWB17393
ANNELIDA (WORMS)	Oligochaeta	1	C	C
	Lumbricidae	5	R	-
MOLLUSCA	*Potamopyrgus*	4	C	R
CRUSTACEA	Paraleptamphopidae	5	R	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	VA
	Coloburiscus	7	C	A
	Zephlebia group	7	C	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	A	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	A
	Ecnomidae/Psychomyiidae	6	R	-
	Hydrobiosis	5	R	R
	Confluens	5	-	R
	Hudsonema	6	C	-
	Pycnocentria	7	C	R
	Pycnocentrodes	5	C	C
DIPTERA (TRUE FLIES)	*Harrisius*	6	-	R
	Orthocladiinae	2	R	-
	Polypedilum	3	-	R
	Tanytarsini	3	R	-
	Tanyderidae	4	R	-
ACARINA (MITES)	Acarina	5	-	R
		No of taxa	19	17
		MCI	101	105
		SQMCI	6.0	6.5
		EPT (taxa)	10	9
		%EPT (taxa)	53	53
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 108 Macroinvertebrate fauna of the Waiokura Stream: summer SEM survey sampled on 1 March 2018

Taxa List	Site Code / Sample Number	MCI score	WKR000500 / FWB17032	WKR000700 / FWB17034
ANNELIDA (WORMS)	Oligochaeta	1	A	A
MOLLUSCA	*Potamopyrgus*	4	C	R
CRUSTACEA	Ostracoda	1	A	C
	Paracalliope	5	A	A
	Paraleptamphopidae	5	R	-
	Paranephrops	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	C
	Coloburiscus	7	C	C
	Deleatidium	8	-	R
	Zephlebia group	7	A	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	VA
	Hydrobiosis	5	-	R
	Psilochorema	6	R	C
	Oecetis	4	-	R
	Pycnocentrodes	5	R	-
	Triplectides	5	C	R
DIPTERA (TRUE FLIES)	*Chironomus*	1	R	-
	Harrisius	6	R	-
	Orthocladiinae	2	-	C
	Polypedilum	3	-	R
	Austrosimulium	3	-	C
	Tanyderidae	4	-	C
ACARINA (MITES)	Acarina	5	C	-
		No of taxa	19	19
		MCI	97	94
		SQMCI	5.5	5.2
		EPT (taxa)	8	9
		%EPT (taxa)	42	47
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 109 Macroinvertebrate fauna of the Waiongana Stream: spring SEM survey sampled on 24 October 2017

Taxa List	Site Code	MCI score	WGA000260	WGA000450
	Sample Number		FWB17305	FWB17306
ANNELIDA (WORMS)	Oligochaeta	1	R	C
	Lumbricidae	5	-	R
MOLLUSCA	*Potamopyrgus*	4	R	R
EPHEMEROPTERA (MAYFLIES)	*Coloburiscus*	7	C	-
	Deleatidium	8	XA	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-
	Zelandobius	5	C	C
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	C	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	C
	Costachorema	7	C	R
	Hydrobiosis	5	R	R
	Neurochorema	6	R	-
	Beraeoptera	8	C	-
	Pycnocentrodes	5	C	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	C
	Chironomus	1	-	R
	Maoridiamesa	3	C	R
	Orthocladiinae	2	VA	A
	Tanytarsini	3	-	R
	Empididae	3	R	R
	Austrosimulium	3	R	R
		No of taxa	20	18
		MCI	102	86
		SQMCI	6.6	4.9
		EPT (taxa)	11	6
		%EPT (taxa)	55	33
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 110 Macroinvertebrate fauna of the Waiongana Stream: summer SEM survey sampled on 19 February 2018

Taxa List	Site Code	MCI score	WGA000260	WGA000450
	Sample Number		FWB18069	FWB18070
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	-	C
NEMERTEA	Nemertea	3	C	A
ANNELIDA (WORMS)	Oligochaeta	1	R	A
	Lumbricidae	5	R	-
MOLLUSCA	*Latia*	5	-	R
	Potamopyrgus	4	VA	VA
CRUSTACEA	*Paracalliope*	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	C
	Coloburiscus	7	A	-
	Deleatidium	8	C	-
	Zephlebia group	7	C	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	VA
	Costachorema	7	C	-
	Hydrobiosis	5	A	C
	Neurochorema	6	C	C
	Beraeoptera	8	C	-
	Oxyethira	2	C	C
	Pycnocentria	7	C	R
	Pycnocentrodes	5	VA	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	VA	A
	Eriopterini	5	R	-
	Hexatomini	5	R	-
	Chironomus	1	R	-
	Harrisius	6	R	-
	Maoridiamesa	3	R	-
	Orthocladiinae	2	A	A
	Polypedilum	3	R	-
	Tanytarsini	3	VA	VA
	Empididae	3	C	R
	Muscidae	3	C	-
	Austrosimulium	3	C	-
	Tanyderidae	4	C	R
		No of taxa	31	20
		MCI	94	87
		SQMCI	4.7	4.2
		EPT (taxa)	11	6
		%EPT (taxa)	35	30
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 111 Macroinvertebrate fauna of the Waitara River: spring SEM survey sampled on 20 October 2017

Taxa List	Site Code	MCI score	WTR000540	WTR000850
	Sample Number		FWB17300	FWB17301
ANNELIDA (WORMS)	Oligochaeta	1	C	C
	Lumbricidae	5	R	-
MOLLUSCA	*Latia*	5	C	-
	Potamopyrgus	4	C	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	-
	Coloburiscus	7	R	-
	Deleatidium	8	VA	A
	Zephlebia group	7	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	C	-
	Zelandobius	5	C	-
	Zelandoperla	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	A	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	R
	Costachorema	7	R	-
	Hydrobiosis	5	R	-
	Pycnocentria	7	R	-
	Pycnocentrodes	5	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C
	Eriopterini	5	R	-
	Maoridiamesa	3	-	R
	Orthocladiinae	2	R	A
	Tanytarsini	3	-	R
	Tanyderidae	4	R	-
		No of taxa	21	8
		MCI	110	83
		SQMCI	6.9	4.6
		EPT (taxa)	11	2
		%EPT (taxa)	52	25
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 112 Macroinvertebrate fauna of the Waitara River: summer SEM survey sampled on 9 February 2018

Taxa List	Site Code	MCI score	WTR000540	WTR000850
	Sample Number		**FWB18057**	**FWB18058**
ANNELIDA (WORMS)	Oligochaeta	1	C	A
MOLLUSCA	*Latia*	5	C	-
	Potamopyrgus	4	VA	R
CRUSTACEA	*Paratya*	3	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	-
	Coloburiscus	7	R	-
	Deleatidium	8	R	-
	Zephlebia group	7	C	-
COLEOPTERA (BEETLES)	Elmidae	6	A	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	A
	Hydrobiosis	5	R	-
	Oxyethira	2	C	C
	Paroxyethira	2	-	R
	Pycnocentrodes	5	C	-
	Triplectides	5	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	C
	Eriopterini	5	R	-
	Orthocladiinae	2	A	VA
	Tanytarsini	3	C	A
	Empididae	3	-	R
	Tanyderidae	4	R	-
		No of taxa	19	11
		MCI	97	64
		SQMCI	4.2	2.4
		EPT (taxa)	8	1
		%EPT (taxa)	42	9
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 113 Macroinvertebrate fauna of the Waiwhakaiho River: spring SEM survey sampled on 25 October 2017

Taxa List	Site Code	MCI score	WKH000920	WKH000950	WKH000100	WKH000500
	Sample Number		FWB17319	FWB17321	FWB17330	FWB17331
ANNELIDA (WORMS)	Oligochaeta	1	R	A	-	-
	Lumbricidae	5	-	R	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R	-	-
	Coloburiscus	7	C	-	R	C
	Deleatidium	8	VA	A	VA	XA
	Nesameletus	9	-	R	R	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	C	R	R
	Austroperla	9	-	-	R	-
	Megaleptoperla	9	-	-	R	-
	Zelandobius	5	R	R	-	C
	Zelandoperla	8	R	-	C	A
COLEOPTERA (BEETLES)	Elmidae	6	C	-	VA	C
	Hydraenidae	8	R	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	-	-	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	C	-	C
	Costachorema	7	-	R	R	R
	Hydrobiosis	5	R	-	R	R
	Hydropsyche (Orthopsyche)	9	-	-	R	-
	Psilochorema	6	-	-	C	-
	Beraeoptera	8	R	R	C	C
	Confluens	5	-	-	-	R
	Olinga	9	-	-	-	R
	Pycnocentrodes	5	-	-	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	A	C	C
	Eriopterini	5	-	-	R	-
	Chironomus	1	-	R	-	-
	Maoridiamesa	3	R	R	C	C
	Orthocladiinae	2	VA	VA	C	A
	Tanytarsini	3	C	-	-	-
	Austrosimulium	3	-	R	-	-
		No of taxa	16	16	17	17
		MCI	106	101	131	114
		SQMCI	5.0	3.2	6.8	7.6
		EPT (taxa)	8	8	12	12
		%EPT (taxa)	50	50	71	71
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa				

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

Table 114 Macroinvertebrate fauna of the Waiwhakaiho River: spring SEM survey sampled on 2 March 2018

Taxa List	Site Code	MCI score	WKH000920	WKH000950	WKH000100	WKH000500
	Sample Number		FWB18132	FWB18134	FWB18135	FWB18136
NEMERTEA	Nemertea	3	R	C	-	-
ANNELIDA (WORMS)	Oligochaeta	1	C	R	-	-
	Lumbricidae	5	-	R	-	-
MOLLUSCA	*Physa*	3	-	R	-	-
	Potamopyrgus	4	R	C	-	-
CRUSTACEA	Ostracoda	1	-	-	-	R
	Paratya	3	R	-	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	R	-	R
	Coloburiscus	7	-	-	R	C
	Deleatidium	8	R	R	XA	XA
	Nesameletus	9	-	-	A	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	-	-	R	-
	Megaleptoperla	9	-	-	R	-
	Zelandoperla	8	-	-	A	-
COLEOPTERA (BEETLES)	Elmidae	6	R	C	VA	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C	-	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A	C	VA
	Costachorema	7	-	-	R	C
	Hydrobiosis	5	-	R	C	A
	Hydrochorema	9	-	-	R	-
	Neurochorema	6	-	-	-	R
	Psilochorema	6	-	-	C	-
	Beraeoptera	8	-	-	C	-
	Olinga	9	-	-	R	-
	Oxyethira	2	R	C	-	R
	Pycnocentrodes	5	-	-	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	R	A	VA
	Eriopterini	5	-	-	R	-
	Maoridiamesa	3	-	-	-	C
	Orthocladiinae	2	A	VA	R	A
	Polypedilum	3	-	-	R	-
	Tanytarsini	3	R	C	-	A
	Ephydridae	4	A	C	-	-
	Muscidae	3	R	R	-	C
	Austrosimulium	3	C	-	-	R
		No of taxa	13	17	18	19
		MCI	71	85	132	98
		SQMCI	3.0	2.8	7.6	6.6
		EPT (taxa)	2	4	13	9
		%EPT (taxa)	15	24	72	47
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa				

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

Table 115 Macroinvertebrate fauna of the Whenuakura River: for the spring SEM survey sampled on 1 November 2017 and summer SEM survey sampled on 16 February 2018

Taxa List	Site Code	MCI score	WNR000450	WNR000450
	Sample Number		FWB17399	FWB18062
NEMERTEA	Nemertea	3	-	R
ANNELIDA (WORMS)	Oligochaeta	1	R	A
	Lumbricidae	5	-	C
MOLLUSCA	*Latia*	5	-	R
	Potamopyrgus	4	C	VA
CRUSTACEA	Paraleptamphopidae	5	-	R
	Phreatogammarus	5	A	A
	Paratya	3	VA	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	A
	Mauiulus	5	C	C
	Rallidens	9	R	-
	Zephlebia group	7	-	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	-
COLEOPTERA (BEETLES)	Elmidae	6	-	VA
	Hydrophilidae	5	R	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	VA
	Hydrobiosis	5	-	C
	Neurochorema	6	-	R
	Psilochorema	6	-	R
	Hudsonema	6	R	-
	Oecetis	4	R	R
	Oxyethira	2	-	C
	Paroxyethira	2	-	R
	Pycnocentrodes	5	-	R
	Triplectides	5	R	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C
	Eriopterini	5	R	R
	Hexatomini	5	-	R
	Chironomus	1	R	R
	Orthocladiinae	2	C	R
	Polypedilum	3	-	R
	Tanypodinae	5	C	R
	Tanytarsini	3	-	A
	Tanyderidae	4	-	R
		No of taxa	17	32
		MCI	87	88
		SQMCI	3.5	4.5
		EPT (taxa)	7	10
		%EPT (taxa)	41	31
'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 2017-2018, median MCI scores, predicted scores and 1995-2018 trends

Summary of MCI scores at all SEM sites: significance in relation to various predictive methodologies (Stark and Fowles, 2009; Leathwick, 2008), and trends over the SEM period 1995 to 2018

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI Values						Median 'health' category	Predictive MCI values		Time Trends (1995-2018)			
				Spring 2017	Summer 2018	Range	Medians to date				Distance[1]	REC[2]	P value	FDR p value	+ / -	Trendline MCI range
							Spring	Summer	Overall							
STY000300	CX/H/VA/S/MO/MG	160	7.3	110	104	64-160	111	113	112	Good	109[0]	128[-]	0.08	0.13	-ve	15
STY000400	CX/H/VA/S/MO/MG	70	12.5	100	105	0-160	107	109	108	Good	103[0]	115[0]	0.72	0.86	-ve	16
HRK000085	WW/L/VA/U/MO/MG	5	N/A	83	85	68-100	89	88	89	Fair	N/A	89[0]	0.02	0.04	+ve	10
HTK000350	WX/L/VA/P/MO/LG	60	N/A	113	97	79-115	101	96	97	Fair	N/A	95[0]	<0.01	<0.01	+ve	18
HTK000425	WW/L/VA/P/MO/LG	30	N/A	117	108	91-115	106	103	104	Good	N/A	92[+]	<0.01	<0.01	+ve	12
HTK000745	WW/L/VA/U/MO/MG	5	N/A	102	75	62-101	86	85	86	Fair	N/A	93[0]	0.87	0.90	+ve	13
KPA000250	CX/H/VA/P/MO/MG	240	5.7	120	113	83-131	121	114	117	Good	112[0]	111[0]	<0.01	<0.01	+ve	28
KPA000700	CX/H/VA/P/MO/MG	140	13.5	103	103	78-118	98	94	96	Fair	103[0]	105[0]	<0.01	<0.01	+ve	28
KPA000950	CX/L/VA/P/MO/LG	20	25.2	93	82	76-101	90	81	87	Fair	96[0]	99[-]	0.04	0.07	+ve	13
KTK000150	CW/L/VA/P/HO/LG	420	0	143	132	112-148	137	135	135	Very good	132[0]	131[0]	0.04	0.08	-ve	8
KTK000248	WX/L/VA/P/MO/LG	5	18.1	102	95	87-118	102	102	102	Good	99[0]	96[0]	0.66	0.77	-ve	11
KPK000250	CX/H/VA/IF/MO/MG	380	3.3	132	133	124-139	130	128	130	Very good	118[+]	137[0]	0.08	0.13	+ve	6
KPK000500	CX/H/VA/P/MO/MG	260	9.2	128	123	98-133	121	113	117	Good	107[0]	127[0]	<0.01	<0.01	+ve	20
KPK000660	CX/H/VA/P/MO/LG	170	15.5	119	113	71-128	107	102	103	Good	101[0]	122[-]	<0.01	<0.01	+ve	33
KPK000880	CW/H/VA/P/MO/LG	60	25.7	97	89	66-110	94	88	91	Fair	95[0]	106[-]	<0.01	0.02	+ve	15
KPK000990	CW/L/VA/P/HO/LG	5	31.1	102	74	69-103	94	87	91	Fair	93[0]	96[0]	0.02	0.04	+ve	14
KRP000300	WX/L/VA/P/LO/LG	180	N/A	97	107	80-106	94	96	95	Fair	N/A	92[0]	<0.01	<0.01	+ve	19
KRP000660	WW/L/VA/P/LO/LG	120	N/A	101	98	70-112	96	91	94	Fair	N/A	102[0]	<0.01	<0.01	+ve	24
MKW000200	CX/H/VA/IF/MO/MG	380	2.3	131	124	100-142	131	124	129	Very good	121[0]	130[0]	0.92	0.94	+ve	12
MKW000300	CX/H/VA/P/MO/LG	150	15.5	127	113	90-119	110	105	108	Good	101[0]	111[0]	<0.01	<0.01	+ve	18
MGH000950	CW/L/SS/P/HO/LG	120	N/A	104	92	77-104	94	91	92	Fair	N/A	117[-]	<0.01	<0.01	+ve	19
MGN000195	CX/H/VA/P/MO/LG	330	8.7	126	121	113-143	129	123	126	Very good	107[+]	124[0]	0.18	0.25	-ve	9
MGN000427	CX/L/VA/P/HO/MG	140	37.9	117	91	77-115	102	96	98	Fair	91[0]	103[0]	0.44	0.55	+ve	7
MRK000420	WW/L/VA/P/MO/LG	60	N/A	97	84	75-105	93	89	90	Fair	N/A	92[0]	<0.01	<0.01	+ve	16
MGT000488	WN/L/VA/P/LO/LG	30	N/A	76	71	56-91	78	78	78	Poor	N/A	80[0]	0.54	0.65	+ve	9

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI Values						Median 'health' category	Predictive MCI values		Time Trends (1995-2018)			
				Spring 2017	Summer 2018	Range	Medians to date				Distance[1]	REC[2]	P value	FDR p value	+ / -	Trendline MCI range
							Spring	Summer	Overall							
MGT000520	WW/L/VA/U/LO/LG	20	N/A	52	76	44-79	65	70	67	Poor	N/A	88[-]	<0.01	<0.01	+ve	22
MWH000380	WW/L/M/P/MO/LG	200	N/A	72	64	58-85	74	73	74	Poor	N/A	92[-]	0.02	0.05	+ve	6
MWH000490	CN/L/VA/P/MO/LG	190	N/A	88	87	63-102	82	79	80	Fair	N/A	93[-]	<0.01	<0.01	+ve	18
MGE000970	CX/L/VA/P/MO/LG	90	15.6	105	96	86-113	104	99	102	Good	101(0)	101[0]	0.16	0.23	-ve	7
PAT000200	CX/H/VA/IF/MO/MG	500	1.9	139	140	127-150	138	138	138	Very good	125[+]	129[0]	0.16	0.23	+ve	7
PAT000315	CX/H/VA/P/MO/LG	300	12.4	129	113	99-130	116	109	111	Good	103[0]	112[0]	0.02	0.04	+ve	11
PAT000360	CW/L/VA/P/HO/LG	240	19.2	112	99	86-105	99	96	98	Fair	99[0]	109[-]	0.21	0.28	+ve	3
PNH000200	CX/H/YA/IF/MO/MG	270	4.4	130	124	104-137	127	122	124	Very good	115[0]	121[0]	<0.01	<0.01	+ve	13
PNH000900	CW/L/VA/P/MO/LG	20	20.9	109	90	70-114	96	85	90	Fair	98[0]	100[0]	<0.01	<0.01	+ve	18
TNH000090	WW/L/SS/P/MO/LG	85	N/A	107	97	90-107	98	101	100	Good	N/A	110[-]	0.09	0.14	+ve	8
TNH000200	WW/L/SS/P/HO/LG	65	N/A	111	102	92-110	104	102	103	Good	N/A	108[0]	0.80	0.86	-ve	8
TNH000515	WW/L/SS/P/HO/LG	15	N/A	94	86	84-104	96	87	94	Fair	N/A	95[0]	0.65	0.77	-ve	8
TMR000150	CX/H/VA/IF/LO/HG	420	0	140	136	119-152	137	139	138	Very good	132[0]	141[0]	0.16	0.23	+ve	9
TMR000375	CX/L/VA/P/MO/MG	100	10.9	108	101	89-120	107	103	103	Good	105[0]	117[-]	<0.01	<0.01	+ve	19
WAI000110	WW/L/VA/P/MO/LG	50	N/A	101	79	80-101	93	88	91	Fair	N/A	91[0]	<0.01	0.01	+ve	11
WMK000100	WW/L/VA/P/LO/HG	160	0	128	125	121-141	132	130	131	Very good	132[0]	128[0]	0.86	0.90	+ve	5
WMK000298	WW/L/VA/P/MO/MG	1	4	101	94	75-105	94	90	92	Fair	116[-]	103[-]	<0.01	<0.01	+ve	13
WGG000115	CX/H/VA/IF/LO/MG	540	0.7	135	134	122-144	132	134	133	Very good	132[0]	131[0]	0.14	0.22	+ve	8
WGG000150	CX/H/VA/P/LO/MG	380	7.2	130	124	119-139	131	126	129	Very good	110[+]	124[0]	0.41	0.53	+ve	12
WGG000500	CW/L/VA/P/MO/LG	200	23	125	112	91-124	103	102	103	Good	97[0]	110[0]	<0.01	<0.01	+ve	10
WGG000665	CW/L/VA/P/HO/MG	180	29.6	101	89	77-111	100	93	96	Fair	94[0]	102[0]	<0.01	0.01	+ve	12
WGG000895	CW/L/VA/P/HO/LG	40	63	93	91	73-106	96	94	95	Fair	85[0]	92[0]	0.71	0.79	+ve	5
WGG000995	CW/L/VA/P/HO/MG	5	66.6	80	89	69-100	93	86	91	Fair	85[0]	95[0]	0.06	0.11	+ve	11
WKR000500	WW/L/VA/P/MO/LG	150	N/A	101	110	88-114	102	98	100	Good	N/A	97[0]	<0.01	<0.01	+ve	11
WKR000700	WW/L/VA/P/MO/LG	70	N/A	105	104	92-109	99	98	98	Fair	N/A	95[0]	0.45	0.55	-ve	9
WGA000260	CX/L/VA/P/MO/LG	140	16.1	102	94	82-112	99	96	97	Fair	100[0]	99[0]	0.05	0.09	+ve	8
WGA000450	WW/L/VA/P/MO/LG	20	31.2	86	87	72-102	92	87	89	Fair	93[0]	88[0]	<0.01	0.01	+ve	19

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI Values						Median 'health' category	Predictive MCI values		Time Trends (1995-2018)			
				Spring 2017	Summer 2018	Range	Medians to date				Distance[1]	REC[2]	P value	FDR p value	+ / -	Trendline MCI range
							Spring	Summer	Overall							
WTR000540	WX/L/SS/P/HO/LG	100	N/A	110	97	95-102	99	98	99	Fair	N/A	110[-]	N/T	N/T	-	-
WTR000850	WX/L/SS/P/HO/LG	15	N/A	83	64	64-107	91	81	86	Fair	N/A	98[-]	0.08	0.13	+ve	17
WKH000100	CX/H/VA/IF/LO/HG	460	0	131	132	115-147	131	128	130	Very good	132[0]	137[0]	0.21	0.28	+ve	6
WKH000500	CX/H/VA/P/MO/MG	175	10.6	114	98	87-125	112	108	111	Good	105[0]	115[0]	<0.01	<0.01	+ve	13
WKH000920	CX/H/VA/P/HO/LG	20	26.6	106	71	71-110	99	92	94	Fair	95[0]	97[0]	0.97	0.97	+ve	11
WKH000950	CX/H/VA/P/HO/LG	2	28.4	101	85	70-111	92	84	89	Fair	94[0]	97[0]	0.69	0.78	+ve	6
WNR000450	WW/L/SS/P/HO/LG	20	N/A	87	88	81-94	87	88	87	Fair	N/A	109[-]	N/T	N/T	-	-

Notes: ( ) = affected by headwater erosion events; Trend highly significant ($p < 0.01$), significant ($p < 0.05$) and not significant ($p \geq 0.05$); [+ve/-ve/-] = wheter a trend line was positive, negative or absent; N/A = non-ringplain source inside NP sites; N/A^s = soft-bedded sites;^ = highest recorded MCI score for that site; * = lowest recorded MCI score for that site, 1 = Stark and Fowles, 2009' 2 = Leathwick, 2009; N/T = not trended (insufficient data at present).