NORTHLAND MACROINVERTEBRATE MONITORING PROGRAMME

2010 Monitoring Report

Prepared by Stephen R Pohe

Pohe Environmental

For: Northland Regional Council, June 2010.

Cover photo:

The Mangakahia River, one of the State of the Environment monitoring sites, near 'Twin Bridges'.

Recommended citation:

Pohe, S.R. 2010. Northland Macroinvertebrate Monitoring Programme: 2010 monitoring report. Unpublished report prepared by Pohe Environmental for Northland Regional Council. 41p.

Synopsis

This report presents results of the 2010 round of the Northland Macroinvertebrate Monitoring Programme, carried out by Pohe Environmental for the Northland Regional Council (NRC). Thirty-seven State of Environment (SoE) and six Resource Consent (RC) locations (upstream and downstream sites) were assessed throughout Northland. This report also presents the 2010 results with results of previous monitoring undertaken from 1997 (biannual 1997–2002, annual thereafter), looking at trends in the main biotic indices.

Forty-nine benthic samples were taken using the sampling protocols developed by the New Zealand Macroinvertebrate Working Group (Stark *et al.* 2001). These methods outline separate protocols for semi-quantitative sampling of hard-bottomed and soft-bottomed streams, therefore acknowledging the inherent differences in community composition found within. Both hard-bottomed and soft-bottomed streams were sampled during the 2010 monitoring programme using corresponding sampling protocols in approximately equal proportions (24 using C1, 25 using C2).

Data were analysed using the biotic indices taxonomic richness, percentage EPT*, MCI, and SQMCI in order to describe and compare the community assemblages, and consequently report on water quality at each site. Trends were presented using scatterplots with Lowess fitted lines, produced in the statistical package Statistica 8.0.

Waipoua River @ SH12 Rest Area, Mangamuka River @ Iwiatua Road Bridge and Mangahahuru @ end of Main Rd (all SoE sites) recorded clean water this year based on MCI and/or SQMCI results. These were three of the 'top five' sites from last year. Victoria @ Thompsons Bridge and Waipapa @ Forest Ranger (other 'top sites' from previous years) returned lower scores this year, which may be a response to the extended period of stable conditions, low flows, and resulting increases in algal biomass that were observed. However the Victoria and Waipapa Rivers are beginning to record a declining trend.

For a second consecutive year 59% of the sites (22 sites) recorded SQMCI scores of less than 4.00, which is interpreted as water of probable 'severe pollution'. However, a further 24% of sites (9 sites) were recorded in the 'moderate pollution' interpretation. The worst of the SoE sites for 2010, based on MCI and SQMCI results were (worst site first):

- Waiotu @ SH1 Bridge
- Waitangi @ Watea
- Manganui @ Mitaitai Rd
- Wairua @ Purua, and
- Oruru @ Oruru Rd

Utakura @ Okaka Rd Bridge and Waiarohia @ Kamo Tributary Culvert ranked slightly better than 2009. These sites contained low diversity communities this year, and the use of index values for these should be treated with caution. If there are a low number of taxa, the average sensitivity score becomes less reliable. The worst of the RC sites for 2010, based on MCI and SQMCI results were:

- Farm Catchment u/s & d/s (due to no water flow)
- Oxidation Pond A u/s

When considering the MCI and SQMCI trend results collectively 17 (53.1%) of the 32 sites analysed indicated little change. Ten sites (31.3%) indicated a reduction in their biotic index and five sites (15.6%) indicated an increase in their biotic index. Loosely fitting the trends into water quality classes, 71.9% of site trends can be interpreted as probable moderate or probable severe pollution, 21.9% of site trends as mild pollution and 6.3% as clean water.

Contents

1. Introduction

This report presents results of the 2010 round of the Northland Macroinvertebrate Monitoring Programme, carried out by Pohe Environmental for the Northland Regional Council (NRC). This report also presents the 2010 results with results of previous monitoring undertaken from 1997 (biannual 1997–2002, annual thereafter), looking at trends in the main biotic indices. Thirty-seven State of Environment (SoE) and six Resource Consent (RC) locations (upstream and downstream sites) were visited throughout Northland (Fig. 1).

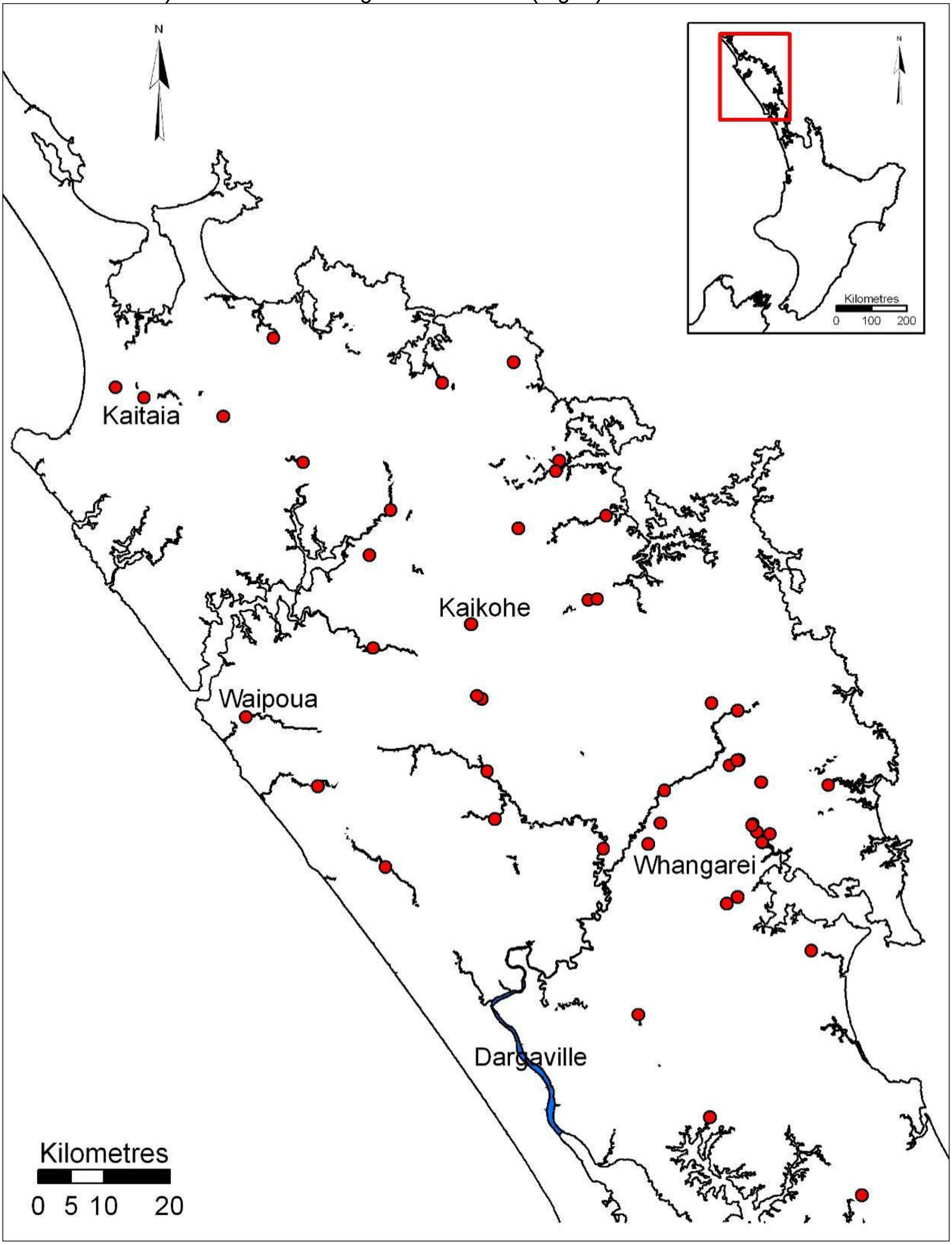

Figure 1. Location of the 49 sites visited during the 2010 Macroinvertebrate Monitoring Programme. Note that several sampling points are hidden by other sampling points.

The data collected during this annual monitoring programme allows the NRC to report on the current water quality of Northland's waterways, and combined with physico-chemical data (collected either concurrently with macroinvertebrate sampling or during River Water Quality Monitoring Network sampling), provides a picture of the condition of Northland's aquatic environment. This data will also be added to the NRC's Freshwater Ecosystems Database, increasing the knowledge of Northland's (and New Zealand's) aquatic ecosystems.

Resource Consent monitoring is required by a number of activities e.g. damming operations, quarries, and companies discharging storm-water or effluent, as a condition of consent, and are monitored upstream and downstream of the consented activity.

Monitoring is undertaken to detect any changes in the aquatic macroinvertebrate communities resulting from human-induced stresses e.g. contaminants entering the waterway. Macroinvertebrates are normally abundant in lotic (running water) ecosystems, and are commonly used in the assessment of water quality as their diverse communities provide varied responses to changing environmental conditions (Boothroyd & Stark 2000). They are good indicators of local conditions because they tend to be limited in their in-stream movements, thus are affected by the environmental conditions over an extended period of time, unlike water quality measurements, which are snapshots of the waterway at that point, at that moment. Initial macroinvertebrate monitoring in New Zealand was carried out following the procedures of Stark (1985), and have been revised several times (Stark 1993, Stark 1998 & Stark *et al*. 2001). More recent publications added revised tolerance scores for taxa collected from soft-bottomed sites (Stark & Maxted 2004, 2007a); the resulting MCI and SQMCI scores being labelled MCI-sb and SQMCI-sb. The Northland Regional Council has acknowledged the usefulness of these publications and has partially adopted the protocol. Rather than using MCI tolerance scores for hard-bottomed sites, and MCI-sb tolerance scores for soft-bottomed sites, NRC have indicated they wish to only use soft-bottomed tolerance scores for naturally occurring soft-bottomed sites. All soft-bottomed sites that are deemed to be 'human induced' are calculated using the conventional MCI i.e. derived from hard-bottomed tolerance scores.

2. Methods

2.1 Sampling protocol

2.1.1 Macroinvertebrate sampling

Forty-nine benthic samples were taken using the sampling protocols developed by the New Zealand Macroinvertebrate Working Group (Stark *et al.* 2001). These methods outline separate protocols for semi-quantitative sampling of hard-bottomed and soft-bottomed streams, therefore acknowledging the inherent differences in community composition found within. Both hard-bottomed and soft-bottomed streams were sampled during the 2010 monitoring programme using corresponding sampling protocols in approximately equal proportions (24 using C1, 25 using C2).

Hard-bottomed sites were characterised by having substrate dominated (>50% by area) by any combination of bedrock, gravel (2.1–16mm), pebbles (16.1–64mm), cobbles (64.1–256mm), or boulders (>256mm in diameter). These sites were sampled using Protocol C1 (hard-bottomed, semi-quantitative), which recommends sampling in riffle habitats and requires each sample to be taken by foot-kick method (Frost *et al.* 1971) using a handheld net (Cuffney *et al*. 1993).

Riffle sections were sampled using a handheld triangular net, ~300mm at the base with 500-micron mesh (500mm deep), and each sample was collected from an area totalling 1m^2 (composed of ten sub-samples of 0.1m^2). Sub-samples were collected while moving progressively upstream, from a range of habitats and flow regimes. Sampling effort was of consistent kicking intensity and duration (seven seconds) and concentrated within the main substrate sizes, in proportion to their occurrence along 50–100m stream reaches.

Soft-bottomed sites were characterised as being dominated by sand (0.063–2mm) or silt (<0.063mm) substrates, often with in-stream macrophytes present. These sites were sampled using Protocol C2 (soft-bottomed, semi-quantitative), which is designed to maximise invertebrate collection in streams that have 'muddy' bottoms, with in-stream macrophytes and woody debris. Stark *et al*. (2001) state that "Woody debris is considered the soft-bottomed stream equivalent to productive riffle habitat targeted for sampling in hard-bottomed streams", and are thus an important component to sample, along with stream bank margins and in-stream macrophytes.

Soft-bottomed sites were sampled using the same handheld triangular net as hard-bottomed sites. Each sample was collected from an area totalling 3m^2 (composed of ten sub-samples of 0.3m^2) while moving progressively upstream. Sampling effort was of consistent intensity and duration (seven seconds) and was concentrated within the main habitat types, in proportion to their occurrence along 50–100m stream reaches. Hard substrates and man-made in-stream items (e.g. concrete) were not sampled.

Bank margins were sampled by jabbing the net into the bank for a distance of 1m, followed by 2–3 cleaning sweeps, to catch any displaced organisms. A similar technique was used for sampling macrophytes which involved moving the net through a 1m stretch of submerged plants (when possible), followed by two cleaning sweeps. Care was taken in both these cases, to avoid collecting excess silt or algae, but this was not always possible.

Submerged woody debris was sampled by holding the wood over the mouth of the net or a buckey, and carefully brushing the surface by hand while washing with stream water to dislodge any invertebrates. Woody debris ranged from 50–150mm in diameter, and each lineal metre represented one unit collection effort (0.3m^2 sub-sample).

All sub-samples were transferred into a white plastic bucket and any pebbles or large organic items i.e. sticks, leaves, macrophytes were carefully rinsed and removed. The sample was gently washed through a 500-micron Endecotts Sieve before being transferred into a plastic container and preserved with 80% ethanol, ready for processing. Each sample was labelled with waterproof paper inside, and the container was labelled externally with pencil. Details of the proportion of different substrate types sampled were also recorded.

Sample processing followed the Protocol P1 (Coded-abundance) as outlined in Stark *et al*. (2001). All samples were rinsed through a 500-micron Endecotts Sieve and processed using a 3-Diopter magnifying light (22W circular). All organisms and their relative numbers were recorded as they were observed in the sorting tray. Each taxon was assigned one of five coded-abundance scores as follows:

R = **R**are (1–4 individuals);
C = **C**ommon (5–19 individuals);
A = **A**bundant (20–99 individuals);
VA = **V**ery **A**bundant (100–499 individuals);
XA = e**X**tra **A**bundant (500+ individuals).

A selection of representatives of each taxon were removed from each sample to confirm identification by microscopic examination, and were stored in vials, as voucher specimens. Macroinvertebrates were identified to the taxonomic level of Stark *et al*. (2001, Appendix B, p. 57), along with several unlisted taxa. The addition of the dipteran subfamily Chironominae replaced lower level taxon, and MCI tolerance scores (hard-bottomed 2.5, soft-bottomed 4.7) were assigned from means of the lower level taxa scores. Identification followed the taxonomic keys and descriptions of Winterbourn *et al*. (2006), Smith & Ward (unpublished), Chapman & Lewis (1976), and Winterbourn (1973). The preserved sample residue of all samples, in their original plastic containers, together with voucher specimen vials, were returned to NRC.

2.1.2 Quality Control (QC)

Quality Control of 10.4% of samples was carried out by an independent taxonomist following the QC1 protocol of Stark *et al*. (2001). A report of quality controlled sample results is presented in Appendix A. Minor differences in 'Abundance-coding 1' were recorded; values being well within the accepted ranges outlined by the protocol. Voucher vials with recorded differences were rechecked by Pohe Environmental; we agree with the QC results 100% and have incorporated the 'missed taxa' into the results.

2.1.3 Habitat assessments and periphyton (P) analysis

Site habitat assessments for River Water Quality Monitoring Network sites (not consent sites) were completed during 2009/10 summer by NRC. The next habitat assessments will be carried out during 2011/12 summer. Periphyton samples (four replicates instead of ten as suggested in the method) were collected following the Quantitative method 1b of Biggs & Kilroy (2000) from 18 hard-bottomed sites (see Table 1, periphyton collection sites indicated with a 'P') selected by NRC. A summary of results are presented in Appendix B (Table 3, Figure 18). Analyses are beyond the scope of this report.

2.1.4 Physico-chemical measurements

Physico-chemical water measurements were taken concurrently with macroinvertebrate sampling, using a YSI Model 85 multiparameter handheld meter that recorded water temperature (°C), dissolved oxygen concentration (mg/L), dissolved oxygen saturation (% air), salinity (ppt), conductivity (µS/cm), and temperature compensated conductivity (25°C) (µS/cm). All physico-chemical water measurements are presented in Appendix C (Tables 4, 5).

2.2 Sampling locations

No additions or deletions were made to the SoE Macroinvertebrate Monitoring Programme this year. One new RC site was established (Farm catchment ds & us). One SoE site, Kaeo River @ Dip Road, was of a different streambed composition to that encountered in 2009. Tables 1 and 2 present the locations and details of the 37 SoE and 6 RC sites, respectively. Each of the RC sites had an upstream and downstream sampling point. The assessed sites contain a large range of physical conditions including large hard-bottomed and soft-bottomed rivers, and small lowland and upper-catchment streams (Figs. 2–5).

Table 1. Locations and details of the 37 State of the Environment sites throughout Northland (u/s = upstream, d/s = downstream, (P) = Periphyton sample taken).

NRC Site No.	Site name	GPS Coordinates (NZ Transverse Mercator)		Sampling protocol and index calculation
		Easting	Northing	
100363	Awanui River @ FNDC watertake (P)	1625095	6113439	C1, MCI
100370	Awanui River u/s of Waihue Channel	1620713	6114952	C2, MCI-sb
109021	Hakaru River @ Topuni Creek farm (P)	1734330	5992416	C1, MCI
100194	Hatea River u/s Mair Park Bridge (P)	1720284	6047290	C1, MCI
102674	Kaeo River @ Dip Road	1670326	6115833	C2, MCI
102256	Kaihu River @ gorge (P)	1661946	6042161	C1, MCI
101530	Kerikeri River @ stone store bridge (P)	1687631	6102447	C1, MCI
100281	Mangahahuru Stream @ Apotu Road Bridge	1714117	6057720	C2, MCI-sb
100237	Mangahahuru Stream @ end of Main Road	1718886	6055192	C1, MCI
101038	Mangakahia River @ Titoki Bridge	1694999	6045028	C2, MCI-sb
109096	Mangakahia River d/s of Twin Bridges (P)	1677333	6056762	C1, MCI
108978	Mangamuka River @ Iwiatua Road Bridge (P)	1649247	6103622	C1, MCI
102257	Manganui River @ Mitaitai Road	1700359	6019751	C2, MCI-sb
101625	Mangere Stream @ Knight Road	1703586	6048948	C2, MCI-sb
109100	Ngunguru River @ Waipoka Road	1729072	6054775	C2, MCI
102258	Opouteke River @ suspension bridge (P)	1678503	6049460	C1, MCI
108979	Oruru River @ Oruru Road	1644740	6122563	C2, MCI-sb
108977	Paparoa Stream @ walking bridge	1711218	6004190	C2, MCI-sb
105231	Punakitere River @ Taheke Recorder	1660001	6075453	C1, MCI
105008	Ruakaka River @ Flyger Road (P)	1726626	6029623	C2, MCI-sb
109020[1]	Utakura River @ Okaka Road Bridge	1656910	6089081	C2, MCI-sb
105532	Victoria River @ Thompsons Bridge (P)	1637132	6110554	C1, MCI
105677	Waiarohia Stream @ Kamo tributary culvert	1717682	6048783	C1, MCI
105674	Waiarohia Stream @ Russell Road Bridge Nth (P)	1718284	6047585	C1, MCI
105672	Waiarohia Stream @ Rust Ave Bridge	1719047	6046013	C1, MCI
107773	Waiarohia Stream @ Whau Valley Road (P)	1717568	6048671	C1, MCI
100007	Waiharakeke Stream @ Stringers Road Bridge (P)	1692604	6082806	C2, MCI-sb
109098	Waimamaku River @ SH12 (P)	1640666	6064914	C1, MCI
102248	Waiotu River @ SH1	1711381	6067240	C2, MCI-sb
108941	Waipao River @ Draffin Road	1701772	6045796	C2, MCI-sb
101751	Waipapa River @ Forest Ranger (P)	1662582	6096421	C1, MCI
101524	Waipapa River @ Waipapa Landing Bridge (P)	1688150	6103986	C2, MCI
103304	Waipoua River @ SH12 Rest Area (P)	1651633	6054443	C1, MCI
101753	Wairua River @ Purua	1704273	6053948	C2, MCI-sb
101752	Waitangi River @ Watea	1695269	6095708	C2, MCI-sb
103178	Waitangi Stream @ Waimate Road	1681894	6093741	C2, MCI
102249	Whakapara River @ cableway	1715259	6066116	C2, MCI-sb

[1] Invertebrate sampling could not be done at the water quality monitoring site. Collection was made upstream at Okaka Road Bridge.

Table 2. Locations and details of the 6 Resource Consent sites throughout Northland (u/s = upstream, d/s = downstream, (P) = Periphyton sample taken).

NRC Site No.	Site name	GPS Coordinates (NZ Transverse Mercator)		Sampling protocol and index calculation
		Easting	Northing	
106508	Dam d/s	1675697	6068165	C1, MCI
106509	Dam u/s	1676506	6067761	C1, MCI
100010	Meatworks d/s	1693927	6082944	C2, MCI-sb
100007	Meatworks u/s (P)	1692604	6082806	C2, MCI-sb
100280	Oxidation Pond A d/s	1715260	6058497	C2, MCI-sb
100279	Oxidation Pond A u/s	1715480	6058620	C2, MCI-sb
103317	Oxidation Pond B d/s (P)	1674860	6079127	C1, MCI
103316	Oxidation Pond B u/s	1674725	6079148	C1, MCI
103824	Quarry d/s	1681164	6118975	C1, MCI
103823	Quarry u/s	1681183	6119003	C1, MCI
108706	Farm catchment d/s	1715338	6037750	C2, MCI-sb
108705	Farm catchment u/s	1713694	6036741	C2, MCI-sb

Figure 2. Hard-bottomed site on the Mangakahia River (Twin Bridges).

Figure 3. Soft-bottomed site on the Mangahahuru Stream.

Figure 4. Lowland site in Whangarei (Waiarohia Stream).

Figure 5. Upper-catchment site in Whangarei (Waiarohia Stream).

2.3 Sampling period

Samples were collected during January (09–19/01/10) to maximise the collection of late-instar insect larvae (for improved taxonomic results), and also to minimise the risk of sample collection being delayed by possible heavy rain events which often occur in Northland during February–March. All samples were collected during stable weather conditions. Streams and rivers across Northland at the time of sampling were below base-flow levels (see Appendix D, Fig 19 for select river flows prior to sampling).

2.4 Data analysis

Data obtained from the samples were entered into Microsoft Excel and analysed in order to describe and compare the community assemblages at each site. Data were transferred to the statistical package Statistica 8.0 to produce scatterplots for trend analysis, with Lowess fitted lines set to a stiffness of 0.4 (following Stark & Maxted (2007b)). The following biotic indices were requested by NRC:

• **Taxonomic richness**
This is a measure of biodiversity and community composition. It records the number of different taxa at each sampling site and describes the community structure. The results of this biometric give an indication of the ecological conservation value of the macroinvertebrate fauna (Poynter 2003).

• **Percentage of Ephemeroptera, Plecoptera and Trichoptera taxa (%EPT*)**
This metric is useful alongside taxonomic richness and is the percentage of the total community that belong to the Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) orders. These three insect orders are generally considered to be more sensitive to organic pollution. The greater the proportions of these orders present in the stream community, the healthier the waterway is considered to be. The caddisflies *Oxyethira* and *Paraoxyethira* (Hydroptilidae) are routinely excluded from this analysis (an asterisk following the %EPT abbreviation indicates the exclusion of Hydroptilidae members), as they are often associated with filamentous algal growths (Collier & Kelly 2006) that often occur in enriched conditions, and thus Hydroptilidae members are considered relatively tolerant to organic pollution.

• **Macroinvertebrate Community Index (MCI and MCI-sb)**

The Macroinvertebrate Community Index (MCI) and its soft-bottomed derivative (MCI-sb) are designed to assess organic enrichment and work by using macroinvertebrates as biological indicators of water quality. They are based on presence of macroinvertebrate taxa, which are assigned scores reflecting their tolerance to environmental changes. Tolerance scores range between 1 and 10 for MCI and between 0.1 and 10 for MCI-sb (1 or 0.1 being highly tolerant, 10 being highly sensitive), and have been predetermined by aquatic ecologists. The final index score for each sample is the sum of the tolerance scores for each taxon present (a_i), divided by the number of taxa (S), and multiplied by 20 (a scaling factor) i.e. $20\sum a_i$ / S (Boothroyd & Stark 2000). A score of 120 or greater indicates 'clean water', scores between 100 and 119 indicate 'possible mild pollution', scores between 80 and 99 indicate 'probable moderate pollution', and scores lower than 80 are considered as having 'probable severe pollution' (Boothroyd & Stark 2000).

When interpreting the MCI it is important to acknowledge the 'fuzzy' divisions between quality classes (Stark & Maxted 2007b), and Stark (1985) suggests a buffer of ± 5 MCI units. The Northland Regional Council requested MCI-sb tolerance scores be used only at naturally occurring soft-bottomed sites and provided a list of sites which were deemed to be naturally soft-bottomed with the aid of REC software (Snelder & Biggs 2002) and NRC habitat assessments. All soft-bottomed sites that are deemed to be 'human induced' are calculated using the conventional MCI and hard-bottomed tolerance scores.

•The Semi-Quantitative Macroinvertebrate Community Index (SQMCI and SQMCI-sb)
These are similar to the MCI, but also take into account the number of individuals belonging to each taxon. Because of this they are considered to be a more accurate reflection of stream health than the MCI, when samples to be compared are collected within a relatively short temporal period.

Tolerance scores for SQMCI and SQMCI-sb are the same as those used for MCI and MCI-sb. The final index score for each sample is the taxon coded abundance (c_i) multiplied by taxon tolerance score (a_i) for each taxon present, summed, and divided by the total coded abundance (M) i.e. $\sum (c_i \, x \, a_i) / M$ (Boothroyd & Stark 2000). Resulting scores are a number between 0.1 and 10; scores >6.00 indicate 'clean water', scores of 5.00 to 5.99 indicate 'possible mild pollution', scores of 4.00 to 4.99 indicate 'probable moderate pollution', and scores of 3.99 and lower indicate 'probable severe pollution' (Boothroyd & Stark 2000).

As with the MCI, it is important to acknowledge the 'fuzzy' divisions between quality classes when interpreting the SQMCI or SQMCI-sb. Stark & Maxted (2007b) suggest a buffer of ± 1.00 unit. As with MCI, the NRC has requested SQMCI-sb tolerance scores be used only with naturally occurring soft-bottomed sites. All soft-bottomed sites that are deemed to be 'human induced' are calculated using the conventional MCI and hard-bottomed tolerance scores.

3. Results

3.1 State of the Environment (SoE) sites

3.1.1 Biotic indices

Raw macroinvertebrate SoE data is tabled in Appendix E. Taxonomic richness at the 37 SoE sites ranged from five at the Paparoa @ walking bridge site to 36 at Waipoua @ SH12 Rest Area site (Fig. 6). The mean number of taxa was 17.2 ± 1.1 (SE, n=37).

The Manganui @ Mitaitai Rd and Paparoa Stream @ walking bridge SoE sites recorded no insect taxa from the orders Ephemeroptera, Plecoptera and Trichoptera (EPT*). In addition, seven other sites only recorded one EPT* taxon. Of the 37 SoE sites which recorded EPT* taxa, the range was 5.9–55.6% (Fig. 7). Thirteen sites (35.1%) scored at least 40% EPT*, however 18 sites in total (48.6%) scored ≤30% EPT* taxa. The mean %EPT* for all 37 SoE sites was 29.9% ± 2.8 (SE, n=37).

Macroinvertebrate Community Index (MCI) scores for the 37 SoE sites ranged from 57.4 (Waiotu @ SH1 Bridge) to 122.3 (Ruakaka @ Flyger Road) (Fig. 8), with a mean of 90.4 ± 2.8 (SE, n=37). Eleven (29.7%) of the sites recorded MCI scores less than 80.0, which can be interpreted as water of probable severe 'organic' pollution (Boothroyd & Stark 2000). Three (8.1%) of the sites scored above 120, which is accepted as the 'clean water' lower limit, however Mangamuka @ Iwiatua Rd Bridge could potentially fall into this category also if the ± 5 unit buffer is considered.

Semi-Quantitative Macroinvertebrate Community Index (SQMCI) results ranged from 2.10 (Waiotu @ SH1 Bridge) to 7.86 (Waipoua @ SH12 Rest Area) (Fig. 9). Twenty-two (59.5%) of the sites recorded SQMCI scores of less than 4.00, which is interpreted as water of probable 'severe pollution'. However, a further nine sites (24.3%) were recorded in the 'moderate pollution' interpretation (total of 83.8% of sites), which is indicated by a low-scoring mean of just 3.87 ± 0.20 (SE, n=37). Only two (5.4%) sites, Waipoua @ SH12 Rest Area and Mangahahuru @ end of Main Rd, scored above 6.00, which is accepted as the 'clean water' lower limit.

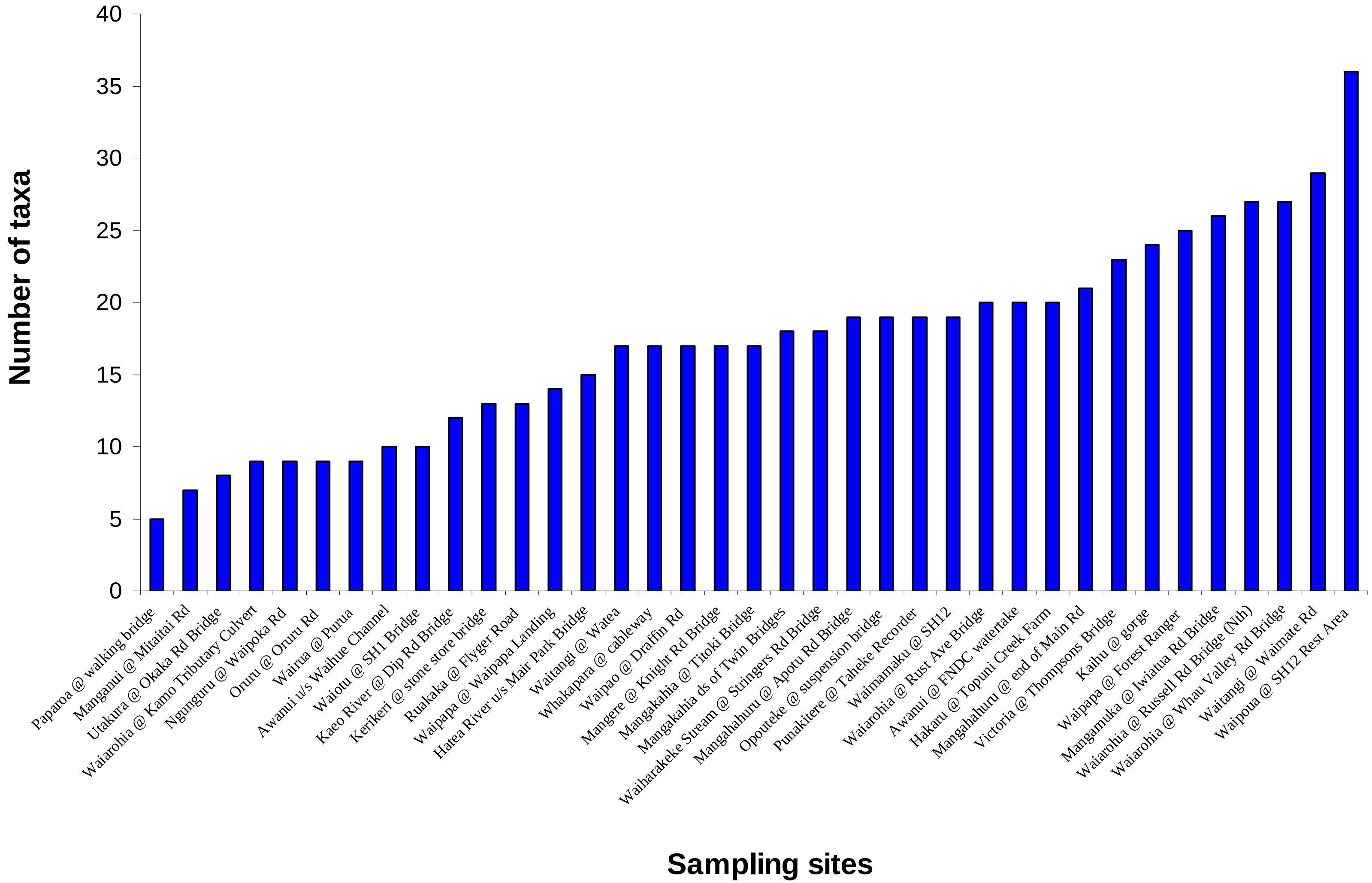

Figure 6. Number of macroinvertebrate taxa recorded from the 37 State of Environment sites for January 2010.

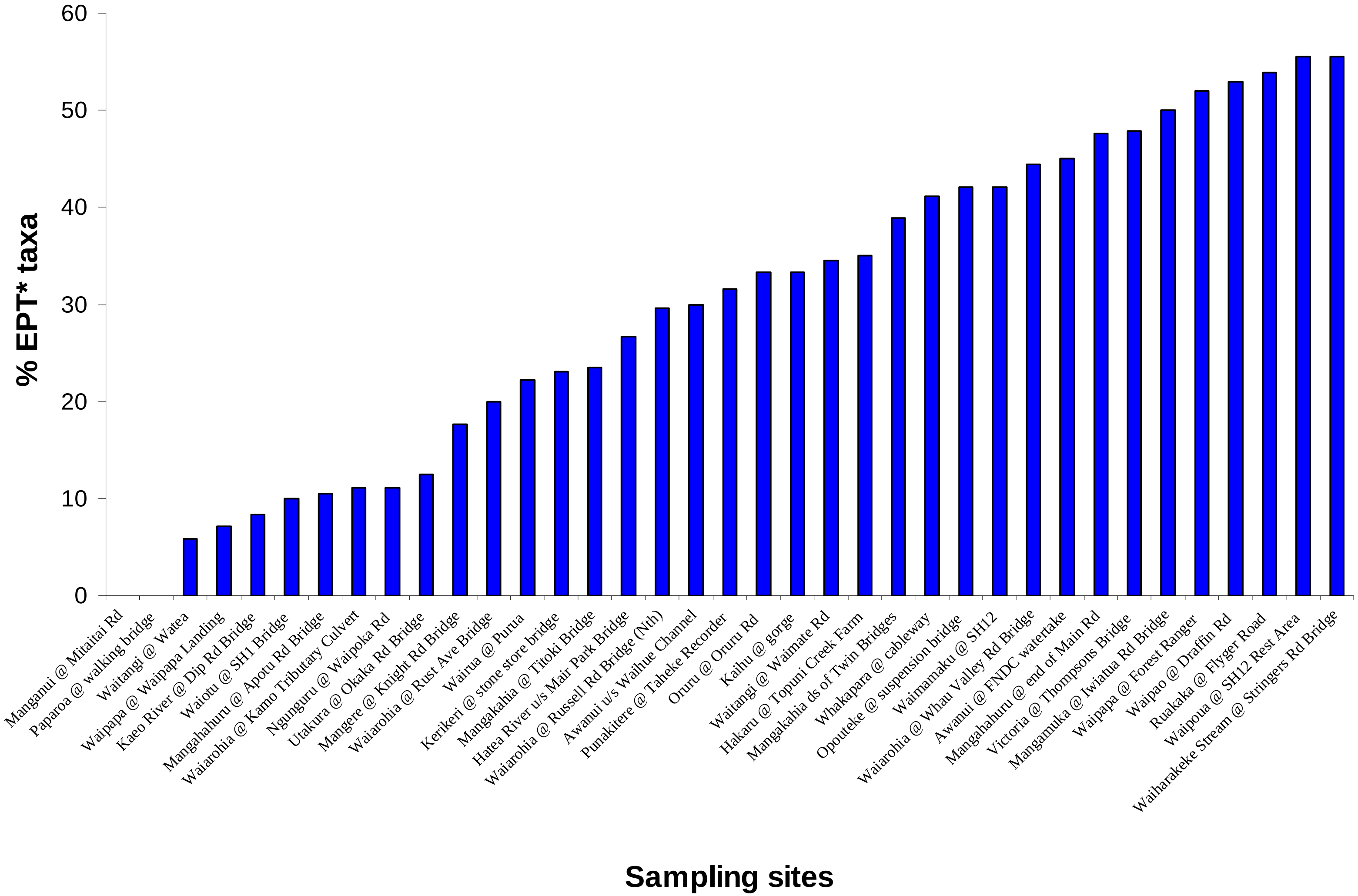

Figure 7. Percentage of Ephemeroptera, Plecoptera, and Trichoptera (excluding Hydroptilidae) taxa from the 37 State of Environment sites for January 2010.

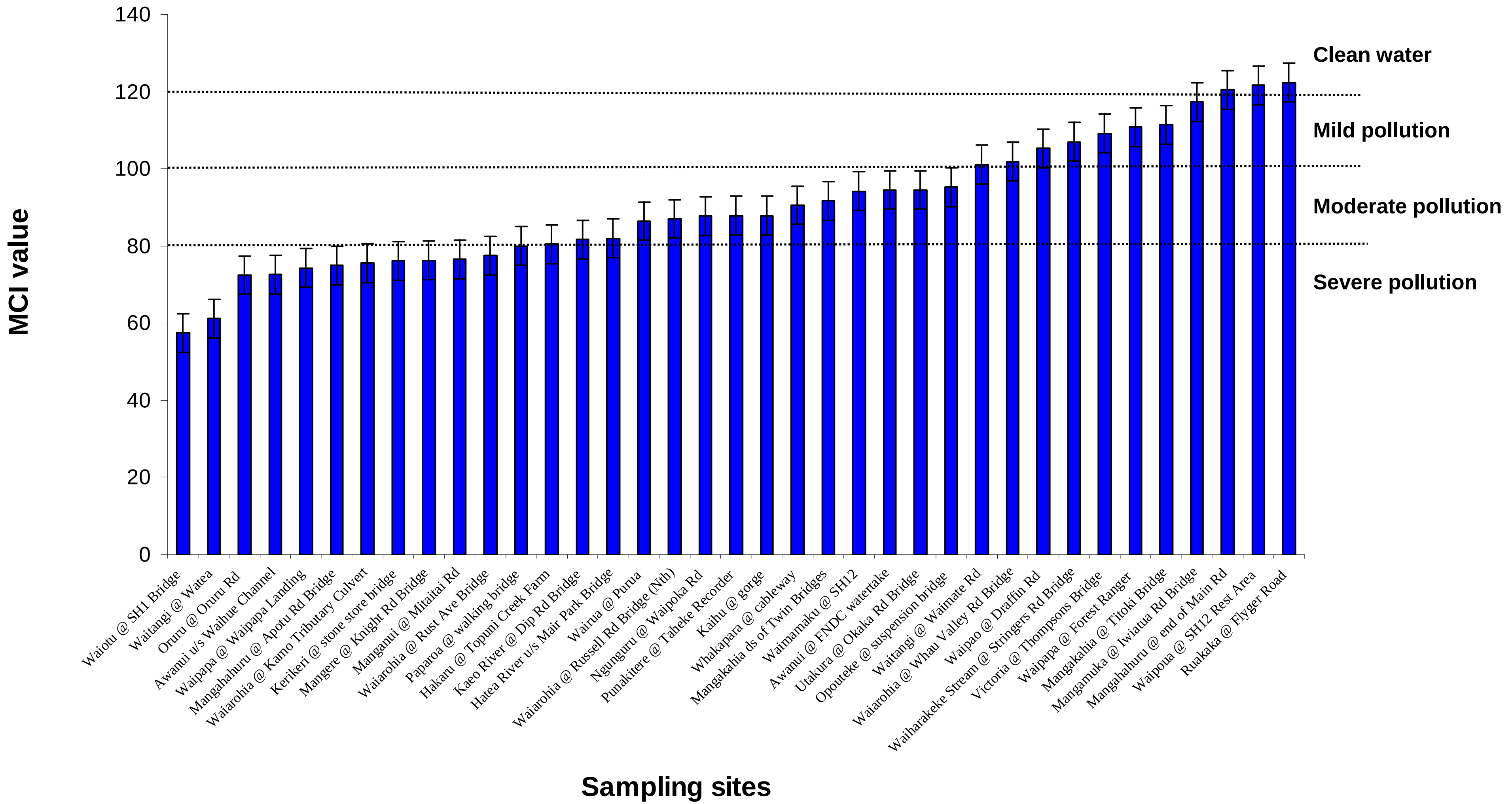

Figure 8. MCI scores for the 37 State of Environment sites for January 2010. Error bars represent ± 5 MCI units.

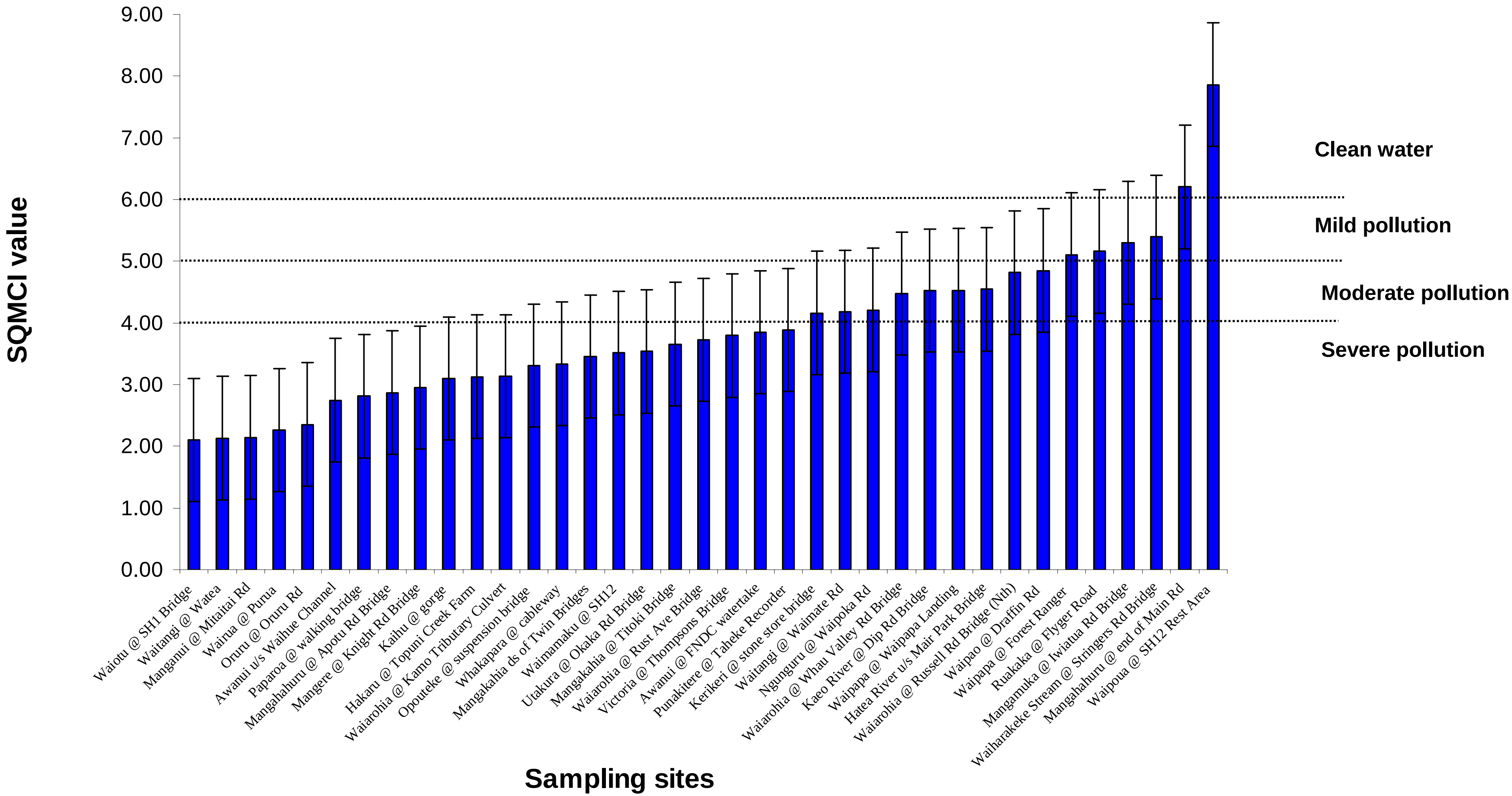

Figure 9. SQMCI scores of the 37 State of Environment sites for January 2010. Error bars represent ± 1 SQMCI unit.

3.2 Resource Consent (RC) sites

3.2.1 Biotic indices

Raw macroinvertebrate RC data is tabled in Appendix F. Taxonomic richness recorded at the six Resource Consent activities (upstream and downstream) ranged from 11 downstream of the Meatworks, to 23 downstream of the Quarry (Fig. 10). The mean number of taxa was 17.3 ± 1.1 (9SE, n=12).

The range of %EPT* taxa was 0.0–52.6% with a mean of 28.4% ± 4.9% (SE, n=12) (Fig. 11). Four (33.3%) of the sites scored highly, these being Oxidation Pond B u/s, Dam d/s, Dam u/s and Meatworks u/s (41.2, 45.0, 45.5, and 52.6% respectively).

MCI values ranged from 38.6 (Farm catchment u/s) to 113.2 (Dam u/s) (Fig. 12) with a mean of 85.1 ± 7.0 (SE, n=12). Upstream and downstream of Oxidation Pond A and the farm catchment (33.3% of RC sites) recorded an MCI score of less than 80, which can be interpreted as water of 'probable severe pollution' (Boothroyd & Stark 2000). No RC sites scored above 120 this year, which is accepted as the 'clean water' lower limit.

The general array of SQMCI results indicated lower-quality conditions than the MCI results, with 75% of sites recorded in the 'probable severe pollution' class. Scores ranged from 1.49–5.45; the mean being 3.34 ± 0.33 (SE, n=12) (Fig. 13). No site recorded 'clean water' with SQMCI this year.

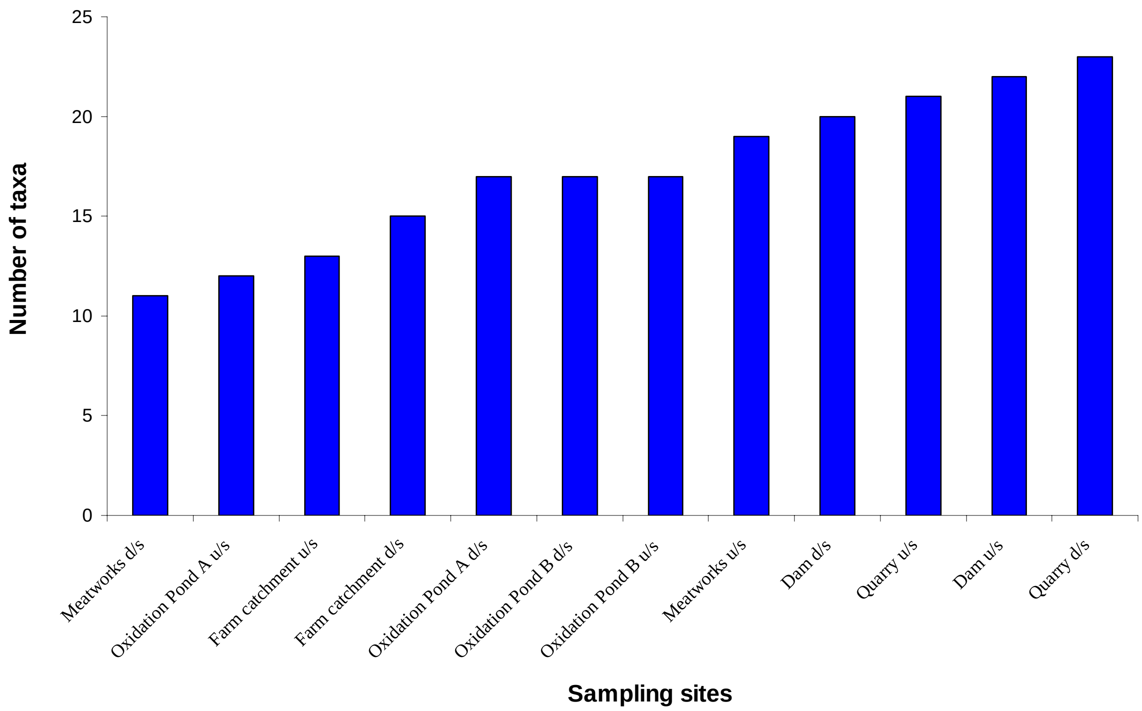

Figure 10. Macroinvertebrate taxonomic richness at the six Resource Consent activities for January 2010, u/s = upstream, d/s = downstream.

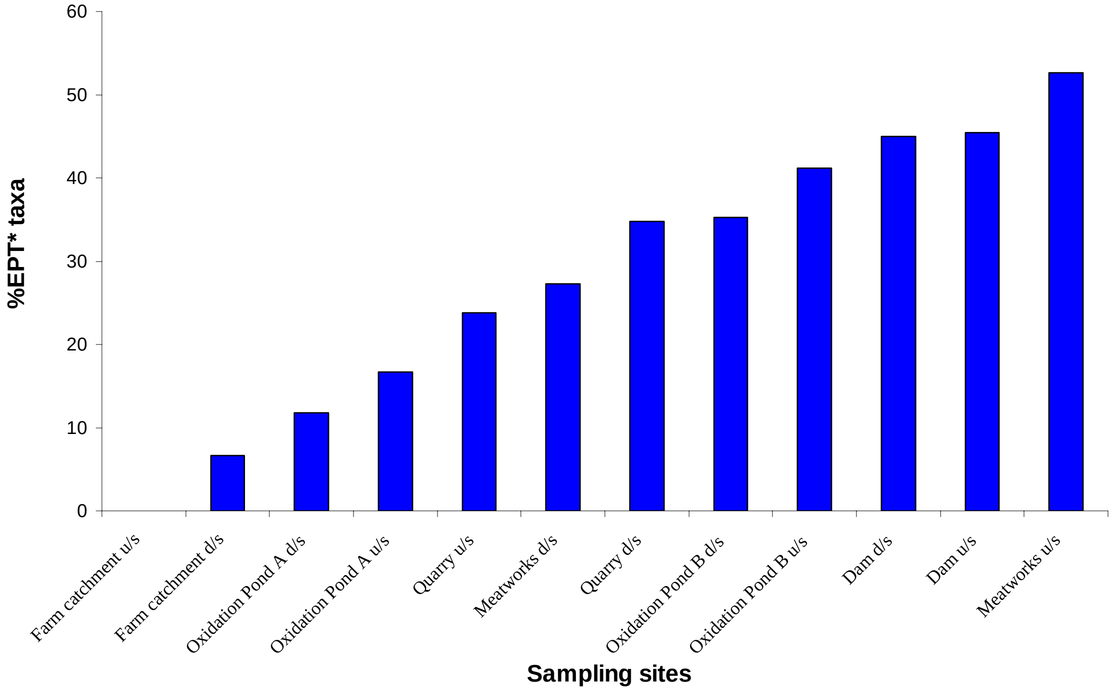

Figure 11. Percentage of Ephemeroptera, Plecoptera, and Trichoptera orders within each sample for the six Resource Consent activities for January 2010, u/s = upstream, d/s = downstream.

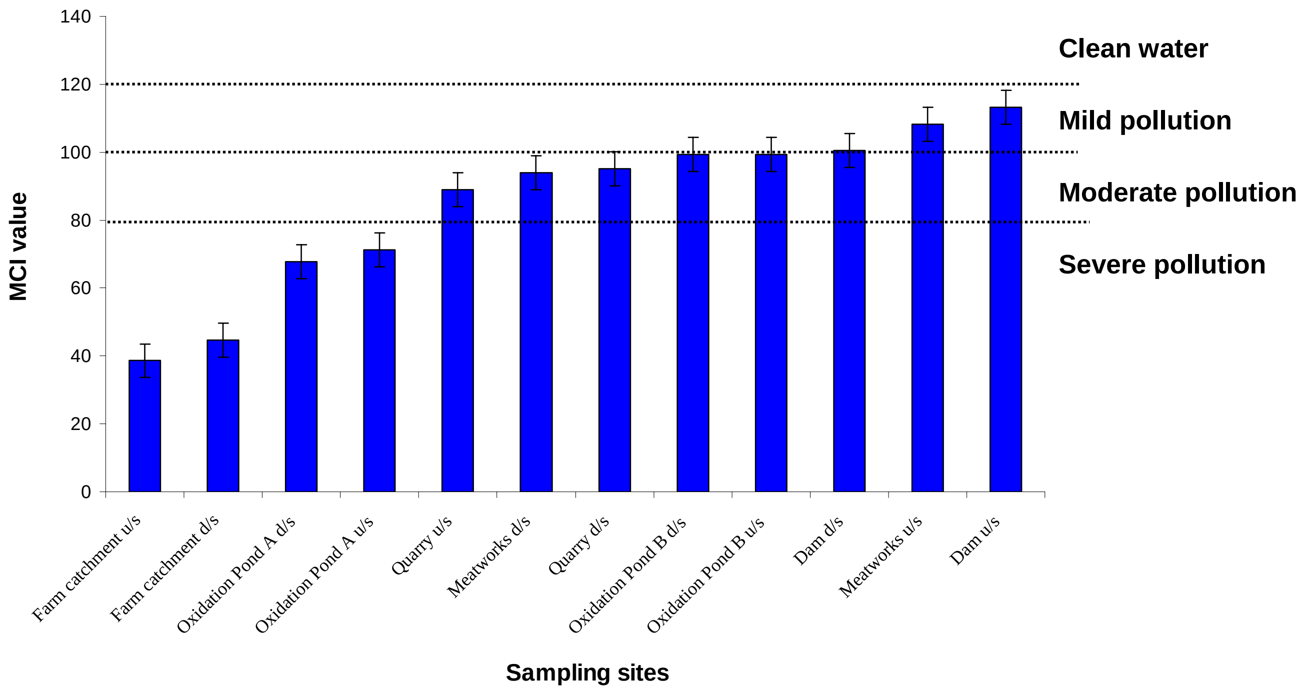

Figure 12. MCI scores for the six Resource Consent activities for January 2010. Error bars represent ± 5 MCI units, which potentially separate water quality classes, u/s = upstream, d/s = downstream.

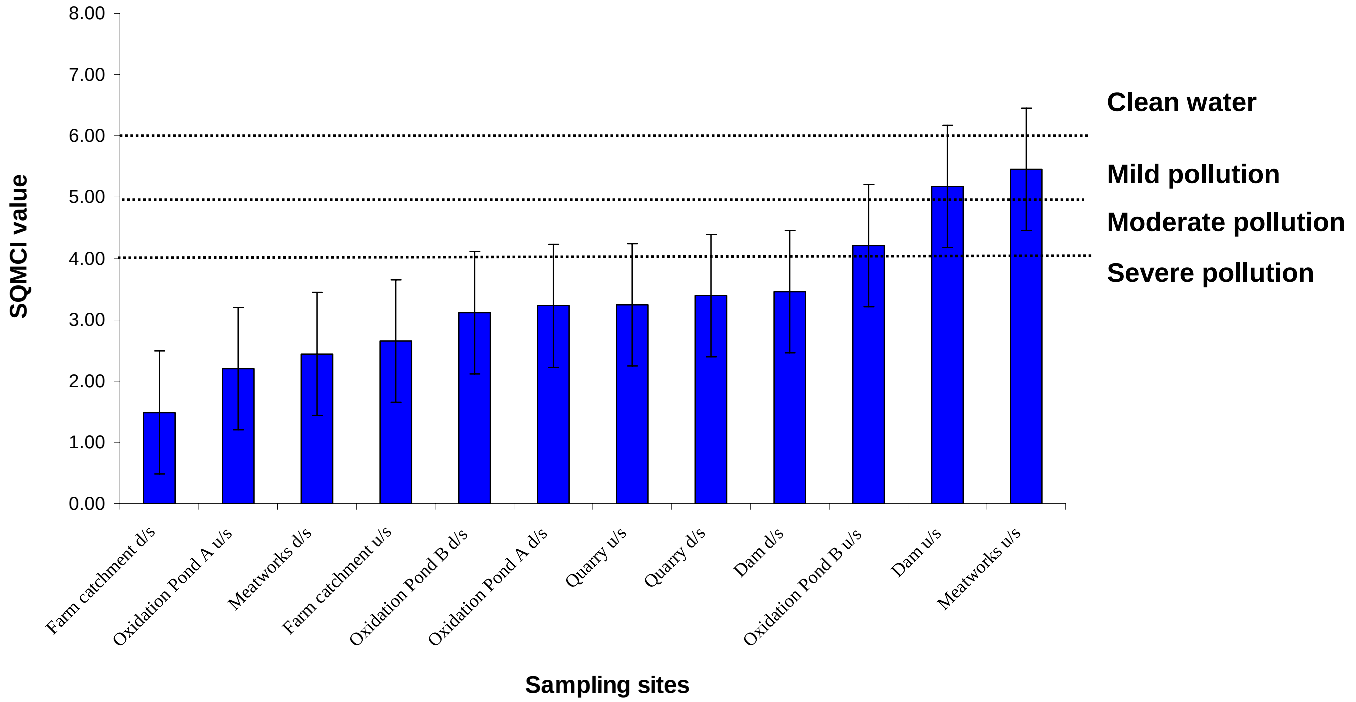

Figure 13. SQMCI scores for the six Resource Consent activities for January 2010. Error bars represent ± 1 SQMCI unit, which potentially separate water quality classes, u/s = upstream, d/s = downstream.

The change in community composition, reflected through SQMCI index scores, from upstream to downstream of the activity, is important in determining whether the consented discharge is having adverse effects on the waterway. One (Meatworks) of the six Resource Consent activities showed a considerable difference between the downstream and upstream SQMCI values (Figs 14, 15). The Dam activity change was also noticeable (but can probably be explained by the lack of suitable habitat for sampling at the downstream site).

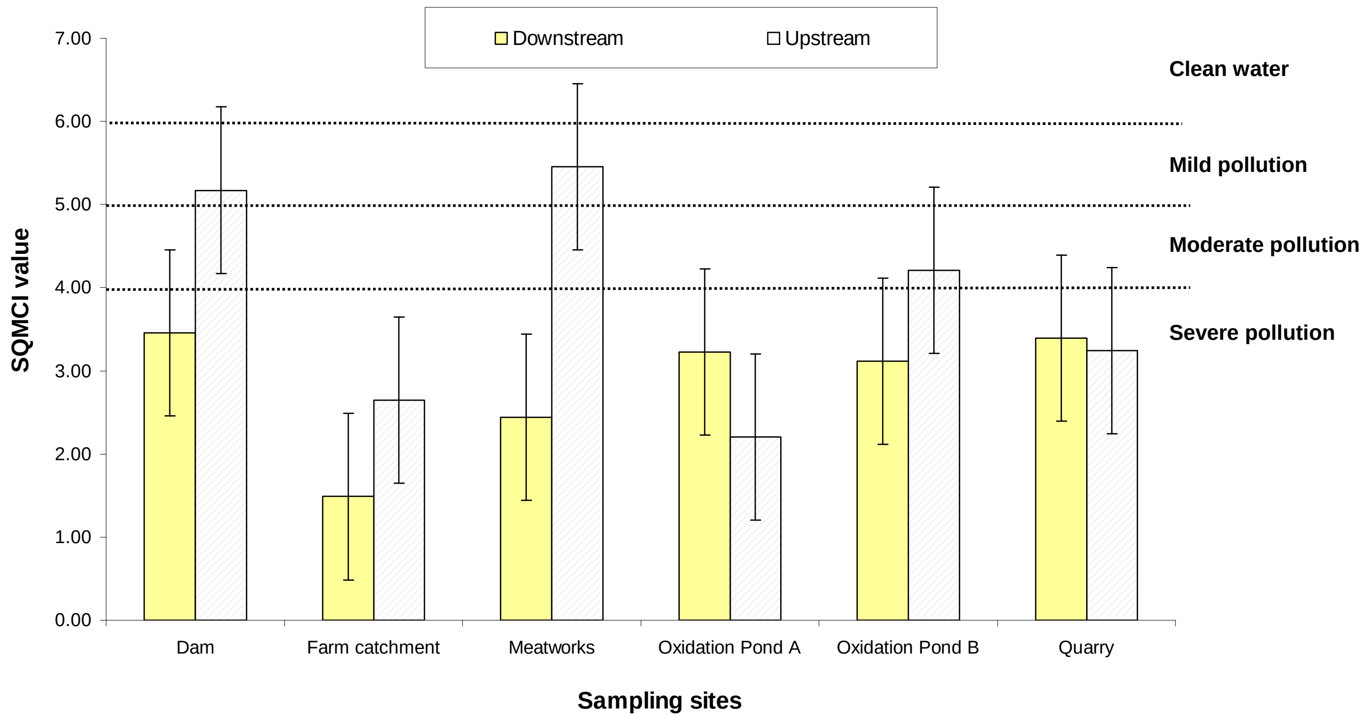

Figure 14. SQMCI values comparing the upstream and downstream sites for January 2010. Error bars represent ± 1 SQMCI unit.

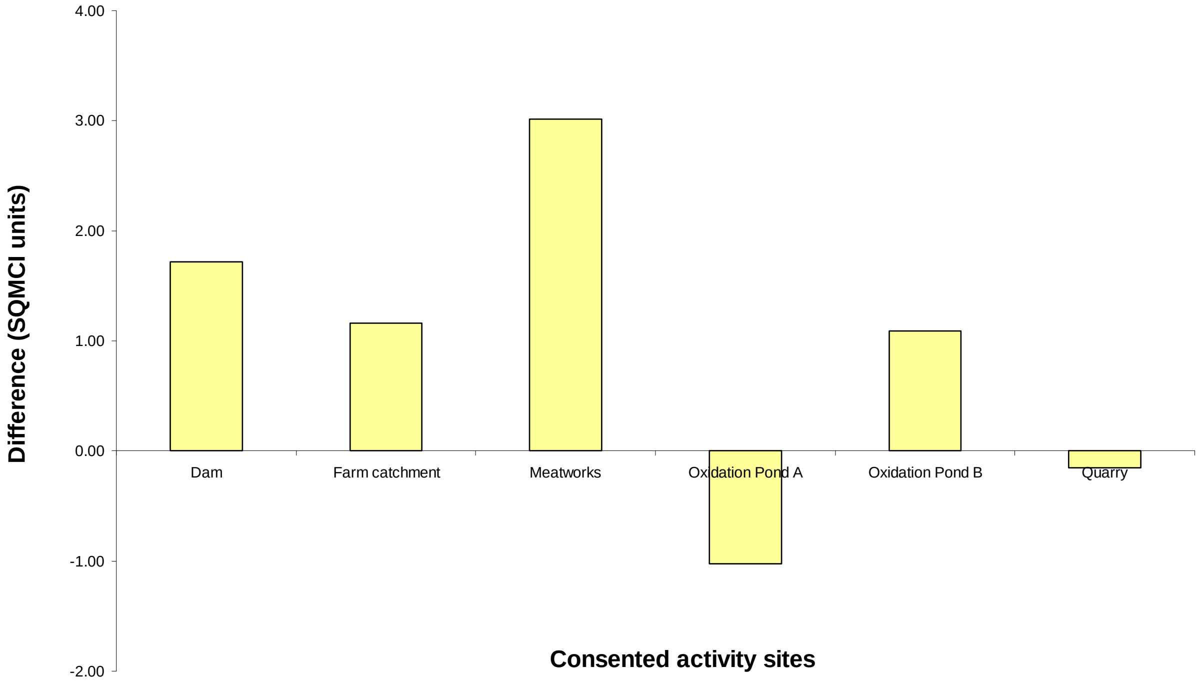

Figure 15. Resource Consent sites showing the difference between upstream and downstream SQMCI values for January 2010.

3.3 Trend analysis

Analysis of 22 (of 37) SoE sites and 10 (of 12) Resource Consent activities was carried out, looking at the MCI and SQMCI results over time (Figs 16, 17). Fifteen (of 37) other SoE sites have been established over the last five years, but were considered inadequate to produce reliable trends, thus were excluded from analysis. Collier & Kelly (2006) considered that a minimum time series of eight occasions were sufficient to detect meaningful ecological (but not statistical) treads in invertebrate data, thus caution should be taken for several of the reported analyses e.g. Waiotu, Waipoua, and Kaihu sites.

When considering the MCI and SQMCI trend results collectively, 17 (53.1%) of the 32 sites analysed indicated little change. A further 10 (31.3%) sites indicated a reduction in their biotic index and five (15.6%) sites indicated an increase in their biotic index.

Also considering the MCI and SQMCI trend results collectively, and loosely fitting the trends into water quality classes presented in Boothroyd & Stark (2000), 71.9% of site trends can be interpreted as 'probable moderate' or 'probable severe pollution', 21.9% of site trends as 'mild pollution' and 6.3% as clean water.

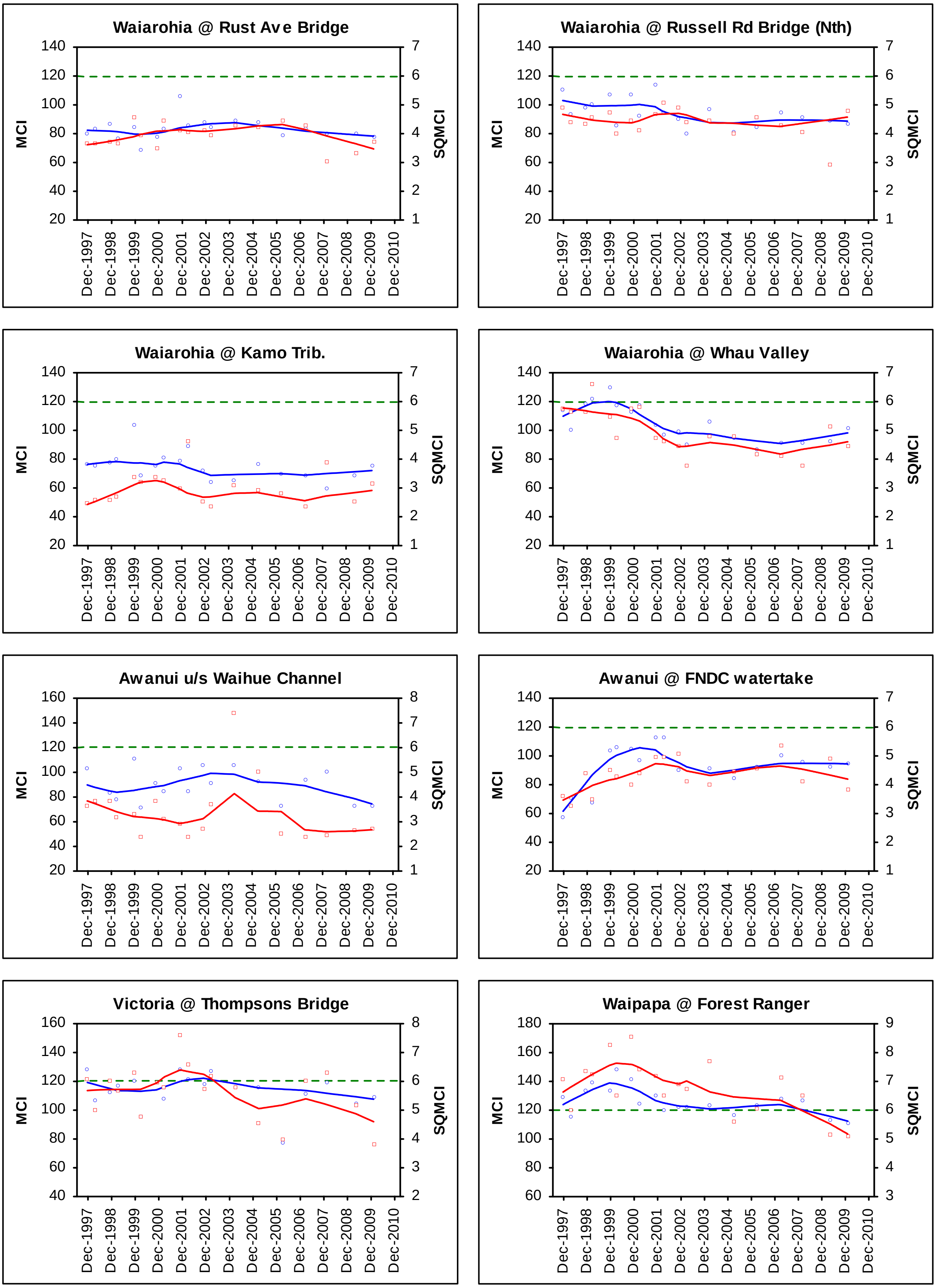

Figure 16. MCI (blue) and SQMCI (orange) trends with LOWESS fitted lines (tension = 0.4) for the SoE monitoring sites. Green dashed lines represent lower clean water limit.

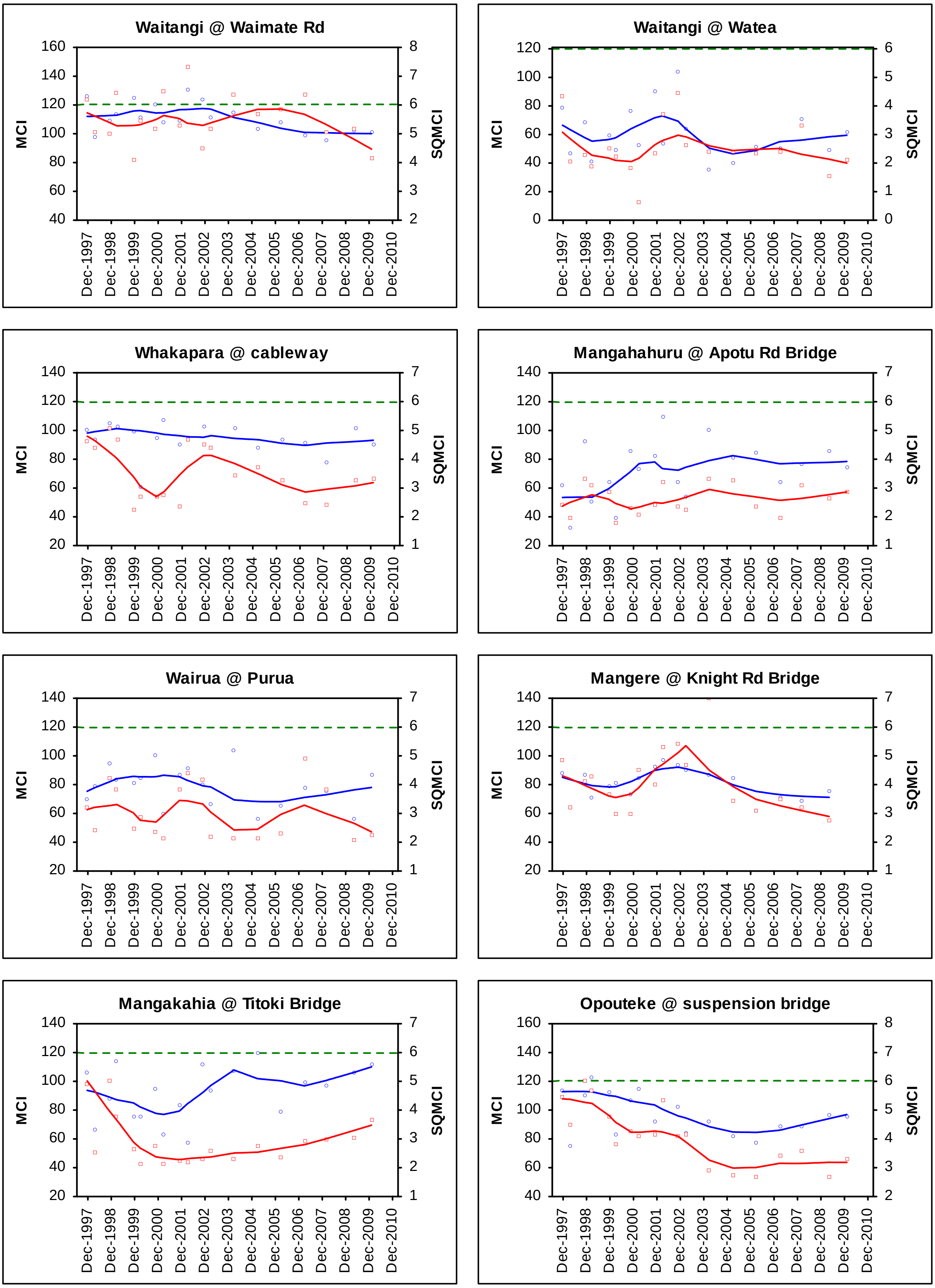

Figure 16 continued. MCI (blue) and SQMCI (orange) trends with LOWESS fitted lines (tension = 0.4) for the SoE monitoring sites. Green dashed lines represent lower clean water limit.

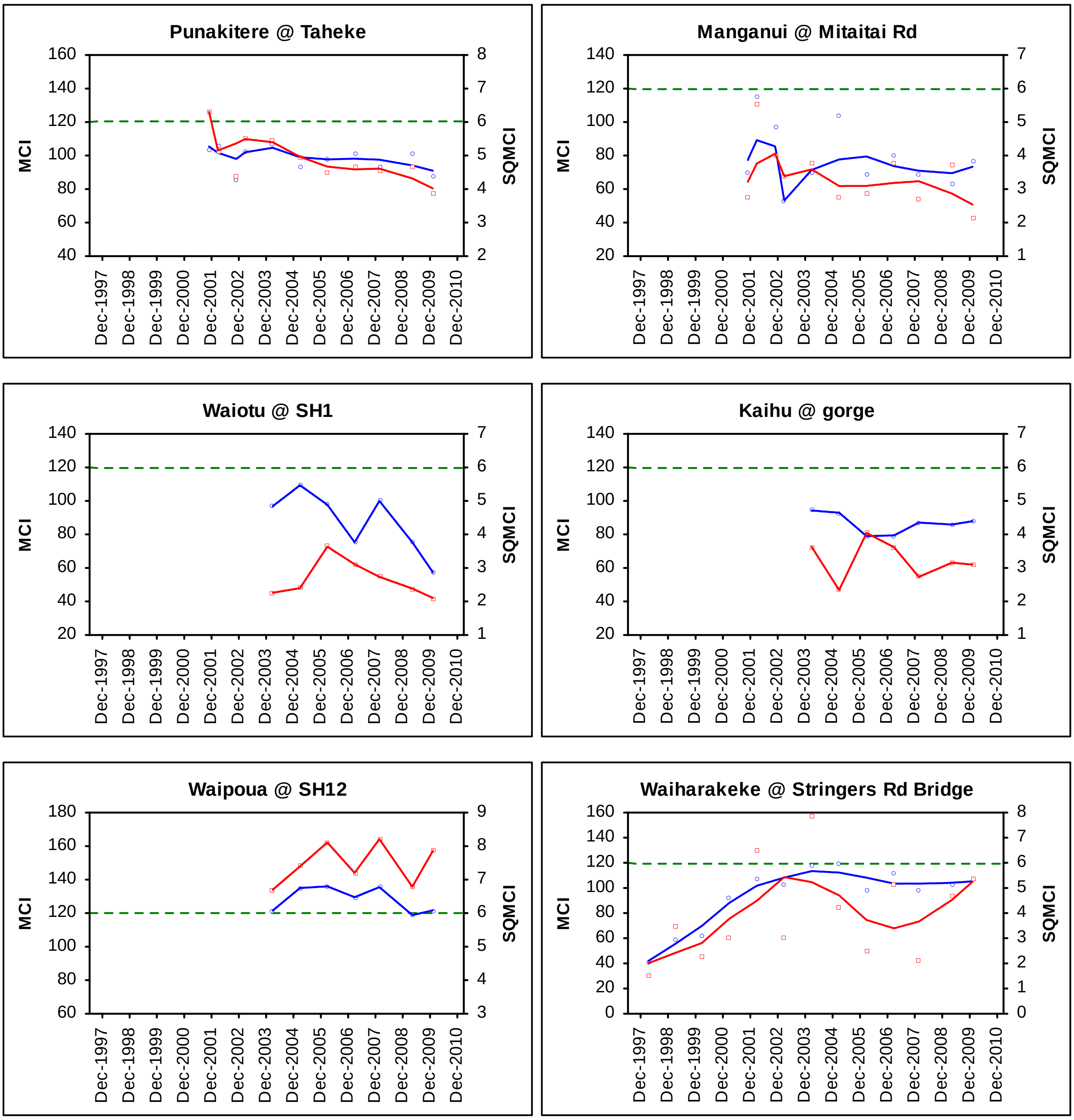

Figure 16 continued. MCI (blue) and SQMCI (orange) trends with LOWESS fitted lines (tension = 0.4) for the SoE monitoring sites. Green dashed lines represent lower clean water limit.

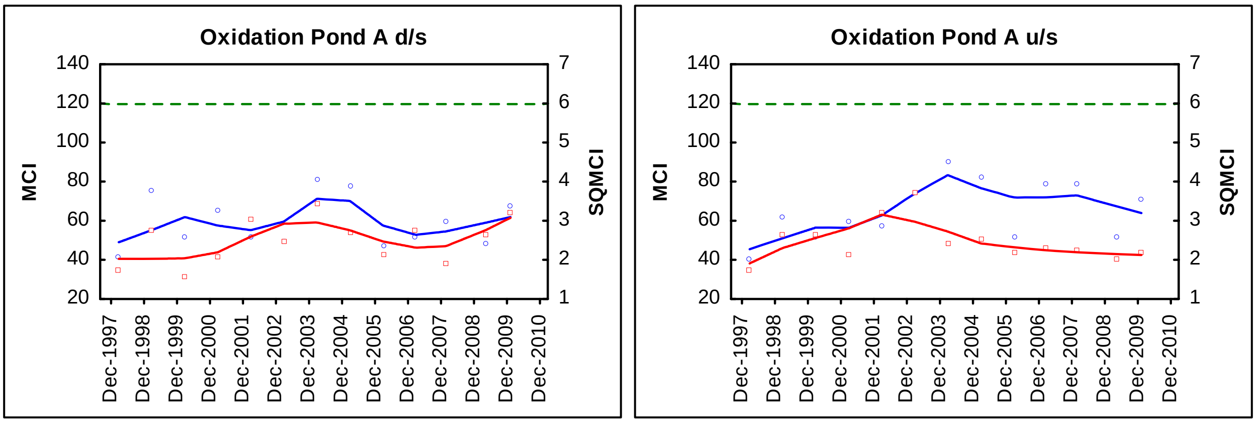

Figure 17. MCI (blue) and SQMCI (orange) trends with LOWESS fitted lines (tension = 0.4) for the Resource Consent activity sites. Green dashed lines represent lower clean water limit.

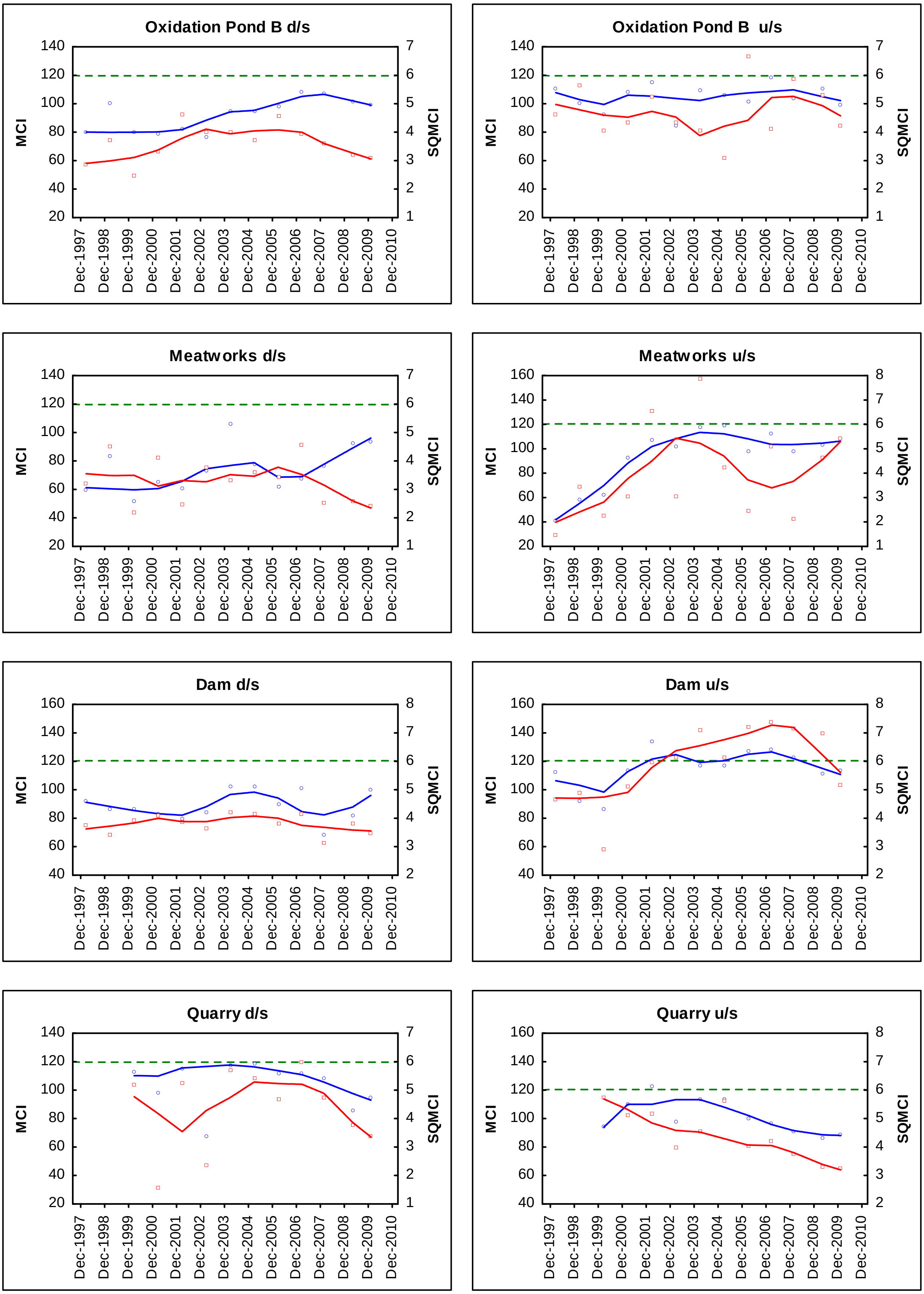

Figure 17 continued. MCI (blue) and SQMCI (orange) trends with LOWESS fitted lines (tension = 0.4) for the Resource Consent activity sites. Green dashed lines represent lower clean water limit.

4. Conclusions

- Waipoua River @ SH12 Rest Area, Mangamuka River @ Iwiatua Road Bridge and Mangahahuru @ end of Main Rd (all SoE sites) recorded clean water this year based on MCI and/or SQMCI results. These were three of the 'top five' sites from last year. Victoria @ Thompsons Bridge and Waipapa @ Forest Ranger (other 'top sites' from previous years) returned lower scores this year, which may be a response to the extended period of stable conditions, low flows, and resulting increases in algal biomass that were observed. However the Victoria and Waipapa Rivers are beginning to record a declining trend.

- For a second consecutive year 59% of the sites (22 sites) recorded SQMCI scores of less than 4.00, which is interpreted as water of probable 'severe pollution'. However, a further 24% of sites (9 sites) were recorded in the 'moderate pollution' interpretation. The worst of the SoE sites for 2010, based on MCI and SQMCI results were (worst site first; repeat offenders in **bold**):

  - Waiotu @ SH1 Bridge
  - **Waitangi @ Watea**
  - Manganui @ Mitaitai Rd
  - **Wairua @ Purua**, and
  - Oruru @ Oruru Rd

  Utakura @ Okaka Rd Bridge and **Waiarohia @ Kamo Tributary Culvert** ranked slightly better than 2009. These sites contained low diversity communities this year, and the use of index values for these should be treated with caution. If there are a low number of taxa, the average sensitivity score becomes less reliable.

- The worst of the RC sites for 2010, based on MCI and SQMCI results were:

  - Farm Catchment u/s & d/s (due to no water flow)
  - Oxidation Pond A u/s

- When considering the MCI and SQMCI trend results collectively 17 (53.1%) of the 32 sites analysed indicated little change. Ten sites (31.3%) indicated a reduction in their biotic index and five sites (15.6%) indicated an increase in their biotic index.

- Also considering the MCI and SQMCI trend results collectively, and loosely fitting the trends into water quality classes, 71.9% of site trends can be interpreted as probable moderate or probable severe pollution, 21.9% of site trends as mild pollution and 6.3% as clean water.

  The following four sites indicated the most apparent decreasing trends, though no statistical tests were undertaken (repeat offenders in **bold**):

  - **Quarry upstream**
  - **Quarry downstream**
  - **Mangere @ Knight Rd Bridge**
  - Waipapa @ Forest Ranger

5. References

Biggs, J.F. & Kilroy, C. 2000. Stream periphyton monitoring manual. Prepared for The New Zealand Ministry for the Environment. NIWA. Christchurch. 226 p.

Boothroyd, I.K & Stark, J.D. 2000. Use of invertebrates in monitoring. *In*: Collier, K.J. & Winterbourn, M.J. *eds. New Zealand stream invertebrates: ecology and implications for management*. New Zealand Limnological Society, Christchurch. Pp 344–373.

Chapman, M.A. & Lewis, M.H. 1976. *An introduction to the freshwater Crustacea of New Zealand*. William Collins Ltd. Auckland. 261 p.

Collier, K.J. & Kelly, J. 2006. Patterns and trends in the ecological condition of Waikato streams based on the monitoring of aquatic invertebrates from 1994 to 2005. Environment Waikato Technical Report 2006/04. 28 p.

Cuffney, T.F., Gurtz, M.E. & Meador, M.R. 1993 *Methods for collecting benthic invertebrate samples as part of the national water-quality assessment program*. United States Geological Survey, Report No. 93–104. 66 p. (http://water.usgs.gov/nawqa/protocols/OFR-93-406).

Frost, S., Huni, A. & Kershaw, W.E. 1971 Evaluation of a kicking technique for sampling stream bottom fauna. *Canadian Journal of Zoology 49*: 167–173.

Poynter, M. 2003. *Kaeo River Environmental Monitoring Programme. Aquatic Macroinvertebrate Survey.* Prepared by Poynter & Associates Environmental Ltd. and Amy Bazeley Ecological Services for Northland Regional Council. 9 p.

Smith, B.J. & Ward, J.B. Unpublished. *An identification guide to the New Zealand hydrobiosid caddisflies (Insecta: Trichoptera).* 151 p.

Snelder, T.H. & Biggs, B.J.F. 2002. Multiscale River Environment Classification for water resources management. *Journal of the American Water Resources Association 38*: 1225–1239.

Stark, J.D. 1985. *A Macroinvertebrate Community Index of water quality for stony streams*. Water and Soil Miscellaneous Publication No 87. National Water and Soil Conservation Authority, Wellington. 53 p.

Stark, J.D. 1993. Performance of the Macroinvertebrate Community Index: effects of sampling method, sample replication, water depth, current velocity, and substratum on index values. *New Zealand Journal of Marine and Freshwater Research 27*: 463–478.

Stark, J.D. 1998. SQMCI: a biotic index for freshwater macroinvertebrate coded-abundance data. *New Zealand Journal of Marine and Freshwater Research 32*: 55–66.

Stark, J.D. & Maxted, J.R. 2004. *Macroinvertebrate Community Indices for Auckland's soft-bottomed streams and applications to SOE reporting*. Report prepared for Auckland Regional Council. 59 p.

Stark, J.D. & Maxted, J.R. 2007a. A biotic index for New Zealand's soft-bottomed streams. *New Zealand Journal of Marine and Freshwater Research 41*: 43–61.

Stark, J.D. & Maxted, J.R. 2007b. *A user guide for the Macroinvertebrate Community Index*. Prepared for The New Zealand Ministry for the Environment. Cawthron Report No.1166. 58 p.

Stark, J.D., Boothroyd, I. K. G., Harding, J. S., Maxted, J. R. & Scarsbrook, M. R. 2001. *Protocols for sampling macroinvertebrates in wadeable streams*. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for The New Zealand Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57 p.

Winterbourn, M.J. 1973. A guide to the freshwater Mollusca of New Zealand. *Tuatara 20*: 141–159.

Winterbourn, M.J., Gregson, K.L.D. & Dolphin, C.H. 2006. Guide to the aquatic insects of New Zealand. *Bulletin of the Entomological Society of New Zealand 14*, 108 p.

6. Acknowledgements

Many thanks to the following NRC staff: Alan Bee for providing hydrological data, Dean Alsop and Dianna Bradshaw for sending off daily periphyton samples for analysis and Sophie Tweddle for general contract communications.

7. Appendix A

Results of 2010 QC as reported by an independent taxonomist are presented below in full. Note that only the format of the QC results was modified, to allow clarity and confidentiality within the report.

Quality control exercise

Examination of stream invertebrate samples from Northland for Pohe Environmental. I re-examined specimens removed from samples from 5 stream sites and scanned the bulk samples to look for any species that may have been missed.

Results

<u>1. Waipoua (103304)</u>
I agree with all identifications made. One specimen of a Hexatomini species was also in the vial and not included in the list.

<u>2. Meatworks u/s (100007)</u>
I agree with all identifications made. Several specimens of Tanypodinae were present in the vial but not listed.

<u>3. Titoki (101038)</u>
I agree with all identifications made.

<u>4. Dam u/s (106509)</u>
I agree with the identifications made but I could not find a *Mauiulus* specimen. The tipulid larva identified as *Paralimnophila* may not be that genus but is Hexatomini. There are therefore two species of Hexatomini in the vial as shown already. The amphipod is a species of Talitridae (heavily infected with fungi). It could be a terrestrial/semi-aquatic species, but as this species also occurred in the Russell Rd sample it may well be aquatic. *Aoteapsyche* was present in the vial and not listed. A mayfly nymph I identified as *Neozephlebia* was found in the bulk sample.

<u>5. Waiarohia @ Russell Rd (105674)</u>
I agree with all identifications made. The most problematic is the worm identified as Nemertea. I think this is correct. Specimens of *Aoteapsyche* were present in the vial but not listed. Note that the snail listed as *Physella* is once again regarded as *Physa*.

Conclusion

The identifications given indicate a high level of expertise and the Council can have confidence in the findings.

Michael Winterbourn
Emeritus Professor
University of Canterbury
21 April 2010

7. Appendix B

Table 3. Summary of peripyhton results from the 18 collection sites. Average Chlorophyll a (mg/sample) and standard errors were derived from four replicate samples (samples analysed by Hill Laboratories). Periphyton taxa were recorded from one sample (samples analysed by NIWA). For full periphyton datasets (including taxon abundances, ash free dry weights, and detection limits) contact Northland Regional Council Monitoring Department. * Some replicate results were below detection limits.

Site name (Site code)	Avg. Chlorophyll a (SE)	Taxa present
Hakaru River @ Topuni Creek farm (TOP)	0.365 (0.076)	**Cyanobacteria**: *Phormidium* sp., *Oscillatoria* sp., *Planktothrix* sp.; **Chlorophyta**: *Cladophora* sp., *Oedogonium* sp.; **Diatoms**: unidentified pennate diatoms, *Navicula* sp., *Gomphonema* sp., *Melosira* sp.; **Flagellates/Unicells <5um**.
Hatea River u/s Mair Park Bridge (HAT)	0.033 (0.026)	**Cyanobacteria**: *Phormidium* sp., *Lyngbya* sp.; **Chlorophyta**: *Enteromorpha* sp., *Scenedesmus* sp.; **Diatoms**: *Epithemia* sp., *Synedra* sp., *Gomphonema* sp., unidentified pennate diatoms, *Melosira* sp.; **Flagellates/Unicells <5um**.
Waiarohia Stream @ Whau Valley Road (WHAU)	0.051 (0.037)	**Cyanobacteria**: *Stigonema* sp.; **Chlorophyta**: *Enteromorpha* sp.; **Diatoms**: *Cymbella* sp., *Epithemia* sp., *Synedra* sp., *Navicula* sp., unidentified pennate diatoms, *Melosira* sp.; **Desmids**: *Spirogyra* sp.; **Flagellates/Unicells <5um**.
Ruakaka River @ Flyger Road (RUA)	0.017 (0.002)	**Cyanobacteria**: *Planktothrix* sp.; **Chlorophyta**: *Stigeoclonium* sp.; **Diatoms**: unidentified pennate diatoms, *Navicula* sp., *Gomphonema* sp.; **Flagellates/Unicells <5um**.
Waiarohia Stream @ Russell Road Bridge (RUS)	0.080 (0.027)	**Cyanobacteria**: *Phormidium* sp.; **Chlorophyta**: *Scenedesmus* sp.; **Diatoms**: unidentified pennate diatoms, *Navicula* sp., *Nitzschia* sp., *Epithemia* sp., *Melosira* sp., *Synedra* sp.; **Flagellates/Unicells <5um**.
Kerikeri River @ stone store bridge (KERI)	0.104 (0.029)	**Cyanobacteria**: *Merismopedia* sp.; **Chlorophyta**: *Oocystis* sp., *Ankistrodesmus falcatus*, *Scenedesmus* sp., *Geminella* sp.; **Diatoms**: unidentified pennate diatoms, *Navicula* sp., *Nitzschia* sp., *Synedra* sp.; **Desmids**: *Spirogyra* sp.; **Flagellates/Unicells <5um**.
Waipapa River @ Waipapa Landing Bridge (LAN)	0.018 (0.002)	**Chlorophyta**: *Microspora* sp., *Scenedesmus* sp., *Cladophora* sp., *Coelastrum* sp., *Oedogonium* sp.; **Diatoms**: unidentified pennate diatoms, *Navicula* sp., *Nitzschia* sp., *Synedra* sp.; **Desmids**: *Spirogyra* sp.; **Flagellates/Unicells <5um**.
Waiharakeke Stream @ Stringers Road Bridge (WAI)	0.004* (<0.001)	**Cyanobacteria**: *Pseudanabaena* sp.; **Chlorophyta**: *Enteromorpha* sp., *Microspora* sp.; **Diatoms**: *Cocconeis* sp., *Navicula* sp., *Synedra* sp., unidentified pennate diatoms, *Cymbella* sp.; **Flagellates/Unicells <5um**.
Mangakahia River d/s of Twin Bridges (TWIN)	0.042 (0.005)	**Chlorophyta**: *Scenedesmus* sp.; **Diatoms**: *Diatoma* sp., *Epithemia* sp., *Synedra* sp., *Navicula* sp., *Gomphoneis* sp., unidentified pennate diatoms, *Melosira* sp.; **Desmids**: *Mougeotia* sp., *Spirogyra* sp.; **Flagellates/Unicells <5um**.
Oxidation Pond B d/s (KOHE)	0.320 (0.082)	**Cyanobacteria**: *Microcystis* sp.; **Chlorophyta**: *Microspora* sp., *Scenedesmus* sp.; **Diatoms**: unidentified pennate diatoms, *Pinnularia* sp., *Diatoma* sp., *Tabellaria* sp., *Nitzschia* sp., *Synedra* sp.; **Desmids**: *Mougeotia* sp., *Spirogyra* sp.; **Flagellates/Unicells <5um**.
Opouteke River @ suspension bridge (OPOU)	0.052 (0.029)	**Cyanobacteria**: *Merismopedia* sp.; **Chlorophyta**: *Cladophora* sp.; **Diatoms**: unidentified pennate diatoms, *Pinnularia* sp., *Cocconeis* sp., *Diatoma* sp., *Epithemia* sp., *Melosira* sp., *Cymbella* sp., *Gomphoneis* sp., *Gomphonema* sp., *Cyclotella* sp.; **Desmids**: *Mougeotia* sp., *Spirogyra* sp.; **Flagellates/Unicells <5um**.
Victoria River @ Thompsons Bridge (VIC)	0.448 (0.104)	**Diatoms**: *Diatoma* sp., *Synedra* sp., *Navicula* sp., *Gomphoneis* sp., *Melosira* sp.; **Desmids**: *Spirogyra* sp.; **Flagellates/Unicells <5um**.
Awanui River @ FNDC watertake (AWA)	0.081 (0.044)	**Chlorophyta**: *Cladophora* sp.; **Diatoms**: unidentified pennate diatoms, *Epithemia* sp., *Navicula* sp., *Gomphonema* sp., *Cocconeis* sp., *Diatoma* sp.; **Flagellates/Unicells <5um**.
Mangamuka River @ Iwiatua Road Bridge (MUKA)	0.538 (0.098)	**Cyanobacteria**: *Microcystis* sp., *Phormidium* sp.; **Chlorophyta**: *Monoraphidium* sp., *Microspora* sp.; **Diatoms**: unidentified pennate diatoms, *Nitzschia* sp., *Cocconeis* sp., *Diatoma* sp., *Navicula* sp., *Melosira* sp., *Cymbella* sp., *Gomphoneis* sp.; **Desmids**: *Mougeotia* sp., *Spirogyra* sp.; **Flagellates/Unicells <5um**.
Waipoua River @ SH12 Rest Area (WAIP)	0.003* (0.000)	**Cyanobacteria**: *Pseudanabaena limnetica*, *Phormidium* sp.; **Chlorophyta**: *Oedogonium* sp., *Zygnema* sp., *Ulothrix* sp.; **Diatoms**: unidentified pennate diatoms, *Nitzschia* sp., *Tabellaria* sp., *Epithemia* sp., *Cocconeis* sp., *Diatoma* sp., *Synedra* sp., *Melosira varians*, *Cymbella* sp., *Gomphonema* sp.; **Desmids**: *Mougeotia* sp., *Closterium acutum* var. *variabile*; **Flagellates/Unicells <5um**.
Kaihu River @ gorge (KAI)	0.086 (0.045)	**Cyanobacteria**: *Phormidium* sp.; **Diatoms**: unidentified pennate diatoms, *Encyonema* sp., *Cocconeis* sp., *Synedra* sp., *Melosira varians*, *Cymbella* sp., *Cyclotella stelligera*, *Gomphoneis* sp.; **Desmids**: *Mougeotia* sp.; **Flagellates/Unicells <5um**.
Waipapa River @ Forest Ranger (FOR)	0.275 (0.073)	**Cyanobacteria**: *Dolichospermum* sp., *Phormidium* sp.; **Diatoms**: unidentified pennate diatoms, *Tabellaria* sp., *Cocconeis* sp., *Diatoma* sp., *Synedra* sp., *Cymbella* sp.; **Desmids**: *Mougeotia* sp., *Spirogyra* sp.; **Flagellates/Unicells <5um**.
Waimamaku River @ SH12 (MAKU)	0.113 (0.013)	**Cyanobacteria**: *Pseudanabaena limnetica*; **Chlorophyta**: *Oedogonium* sp., *Cladophora* sp.; **Diatoms**: unidentified pennate diatoms, *Epithemia* sp., *Cocconeis* sp., *Aulacoseira granulata* var. *angustissima*, *Surirella* sp., *Melosira varians*, *Cymbella* sp., *Gomphoneis* sp.; **Desmids**: *Spirogyra* sp.; **Flagellates/Unicells <5um**.

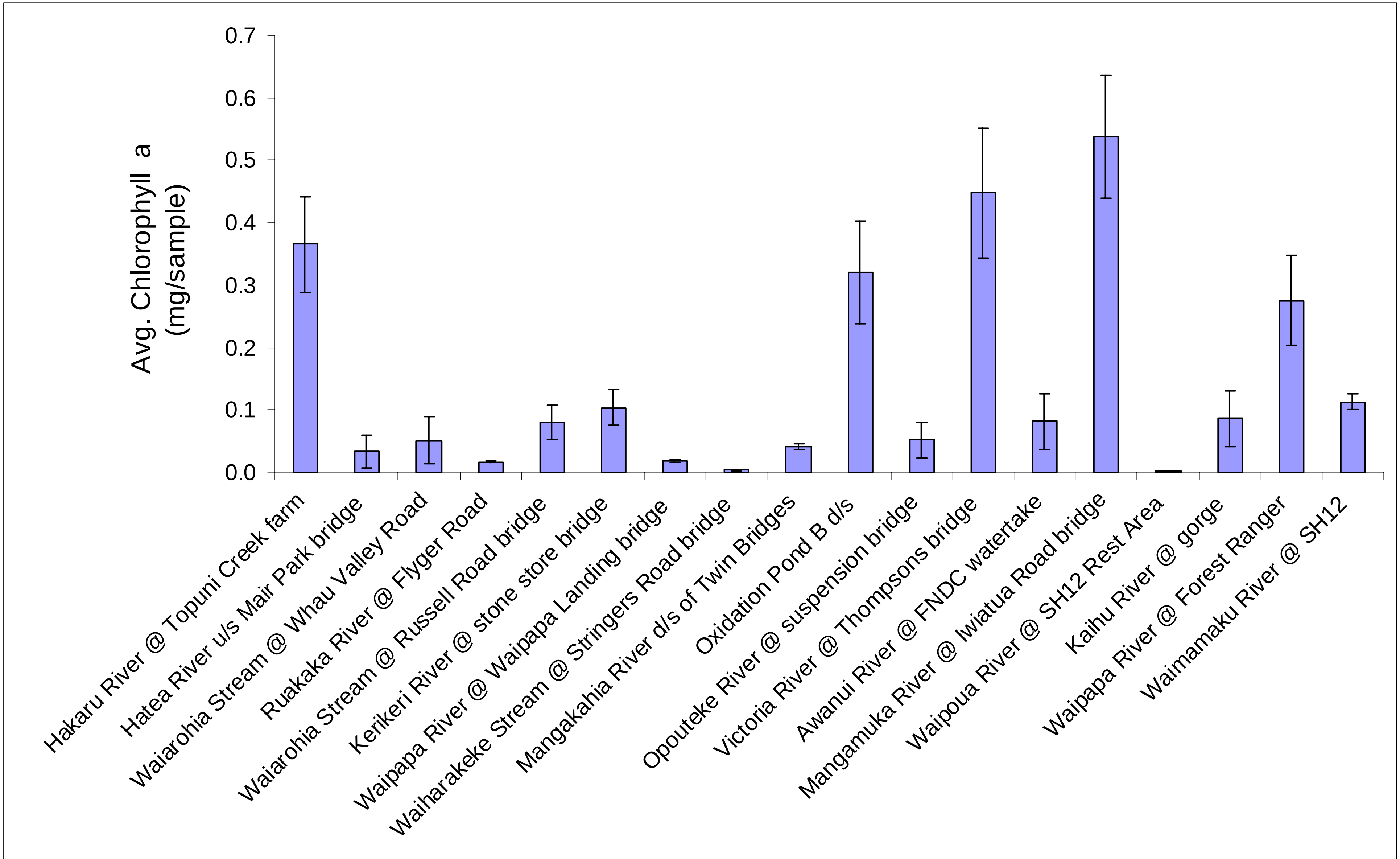

Figure 18. Summary of average Chlorophyll a results (S.E., n=4) from the 18 collection sites. For full periphyton datasets (including taxon abundances, ash free dry weights, and detection limits) contact Northland Regional Council Monitoring Department.

7. Appendix C

Table 4. Physico-chemical data (water temperature, dissolved oxygen, air saturated dissolved oxygen, conductivity, temperature compensated conductivity, and salinity) recorded at the 37 State of the Environment sites throughout Northland (u/s = upstream, d/s = downstream).

Site name	Temp (°C)	D.O. (%)	D.O. (mg/L)	Cond. (μS/cm)	Cond. 25°C‡ (μS/cm)	Sal. (ppt)
Awanui River @ FNDC watertake	22.0	88.6	7.74	204.7	207.0	0.1
Awanui River u/s of Waihue Channel	22.2	89.0	7.75	217.0	229.5	0.1
Hakaru River @ Topuni Creek farm	20.3	111.3	10.06	166.6	183.2	0.1
Hatea River u/s Mair Park Bridge	16.9	92.8	8.98	233.7	276.4	0.1
Kaeo River @ Dip Road	20.8	80.6	7.21	150.4	163.4	0.1
Kaihu River @ gorge	18.0	94.3	8.91	105.1	121.2	0.1
Kerikeri River @ stone store bridge	23.8	105.4	8.91	95.6	97.9	0.1
Mangahahuru Stream @ Apotu Rd Bridge	19.5	105.4	9.68	147.9	165.3	0.1
Mangahahuru Stream @ end of Main Rd	16.2	88.3	8.68	87.0	104.6	0.1
Mangakahia River @ Titoki Bridge	21.8	102.5	8.99	158.5	168.9	0.1
Mangakahia River d/s of Twin Bridges	19.9	87.8	7.99	122.8	136.1	0.1
Mangamuka River @ Iwiatua Road Bridge	21.7	109.5	9.62	174.5	186.1	0.1
Manganui River @ Mitaitai Road	23.0	115.1	9.87	193.7	201.4	0.1
Mangere Stream @ Knight Road	18.4	97.1	9.12	159.1	182.0	0.1
Ngunguru River @ Waipoka Road	20.7	81.9	7.22	4,900	5,340	2.9
Opouteke River @ suspension bridge	18.4	87.2	8.18	126.2	144.4	0.1
Oruru River @ Oruru Road	21.0	80.9	7.21	172.8	187.1	0.1
Paparoa Stream @ walking bridge	23.6	143.0	11.14	23,730	24,390	14.8
Punakitere River @ Taheke Recorder	21.9	99.3	8.70	154.0	163.9	0.1
Ruakaka River @ Flyger Road	17.2	76.9	7.40	205.6	241.6	0.1
Utakura River @ Okaka Road Bridge	20.3	59.9	5.41	101.8	111.8	0.1
Victoria River @ Thompsons Bridge	20.7	105.8	9.49	165.2	180.1	0.1
Waiarohia Stream @ Kamo tributary culvert	15.5	93.7	9.34	168.6	205.8	0.1
Waiarohia Stream @ Russell Rd Bridge Nth	16.0	90.2	8.90	320.8	387.6	0.2
Waiarohia Stream @ Rust Ave Bridge	18.9	117.9	10.94	219.4	248.2	0.1
Waiarohia Stream @ Whau Valley Road	15.2	83.5	8.37	353.5	434.8	0.2
Waiharakeke Stream @ Stringers Rd Bridge	18.0	68.3	6.46	157.7	182.1	0.1
Waimamaku River @ SH12	21.4	102.2	9.03	112.6	120.9	0.1
Waiotu River @ SH1	20.5	104.5	9.41	88.1	96.4	0.0
Waipao River @ Draffin Road	18.9	131.2	12.20	177.4	200.9	0.1
Waipapa River @ Forest Ranger	20.8	92.0	8.23	91.7	99.7	0.1
Waipapa River @ Waipapa Landing Bridge	22.7	92.5	7.97	73.2	76.5	0.0
Waipoua River @ SH12 Rest Area	16.4	94.9	9.29	85.5	102.4	0.1
Wairua River @ Purua	22.3	107.3	9.33	153.2	161.6	0.1
Waitangi River @ Watea	21.6	98.8	8.70	130.9	140.1	0.1
Waitangi River @ Waimate Road	22.0	107.8	9.43	95.8	101.7	0.1
Whakapara River @ cableway	20.3	107.2	9.69	90.4	99.3	0.1

‡ Conductivity temperature compensated to 25°C.

Table 5. Physico-chemical data (water temperature, dissolved oxygen, air saturated dissolved oxygen, conductivity, temperature compensated conductivity, and salinity) recorded at the 6 Resource Consent sites throughout Northland (u/s = upstream, d/s = downstream).

Site name (site number)	Temp (°C)	D.O. (%)	D.O. (mg/L)	Cond. (µS/cm)	Cond. 25°C[§] (µS/cm)	Sal. (ppt)
Dam d/s (106508)	15.6	84.2	8.38	50.4	61.5	0.0
Dam u/s (106509)	16.0	95.5	9.42	129.5	156.3	0.1
Farm catchment d/s (108706)	20.9	93.7	8.36	352.9	382.6	0.2
Farm catchment u/s (108705)	15.7	3.0	0.29	538.0	655.0	0.3
Meatworks d/s (100010)	17.8	49.2	4.68	167.7	194.6	0.1
Meatworks u/s (100007)	18.0	68.3	6.46	157.7	182.1	0.1
Oxidation Pond A d/s (100280)	20.9	109.8	9.81	163.0	177.0	0.1
Oxidation Pond A u/s (100279)	19.9	99.7	9.07	152.5	168.8	0.1
Oxidation Pond B d/s (103317)	17.5	84.3	8.06	165.1	192.9	0.1
Oxidation Pond B u/s (103316)	17.8	96.4	9.17	90.6	105.1	0.1
Quarry d/s (103824)	18.1	74.1	7.00	97.3	112.1	0.1
Quarry u/s (103823)	18.6	73.4	6.85	98.7	112.3	0.1

[§] Conductivity temperature compensated to 25°C.

7. Appendix D

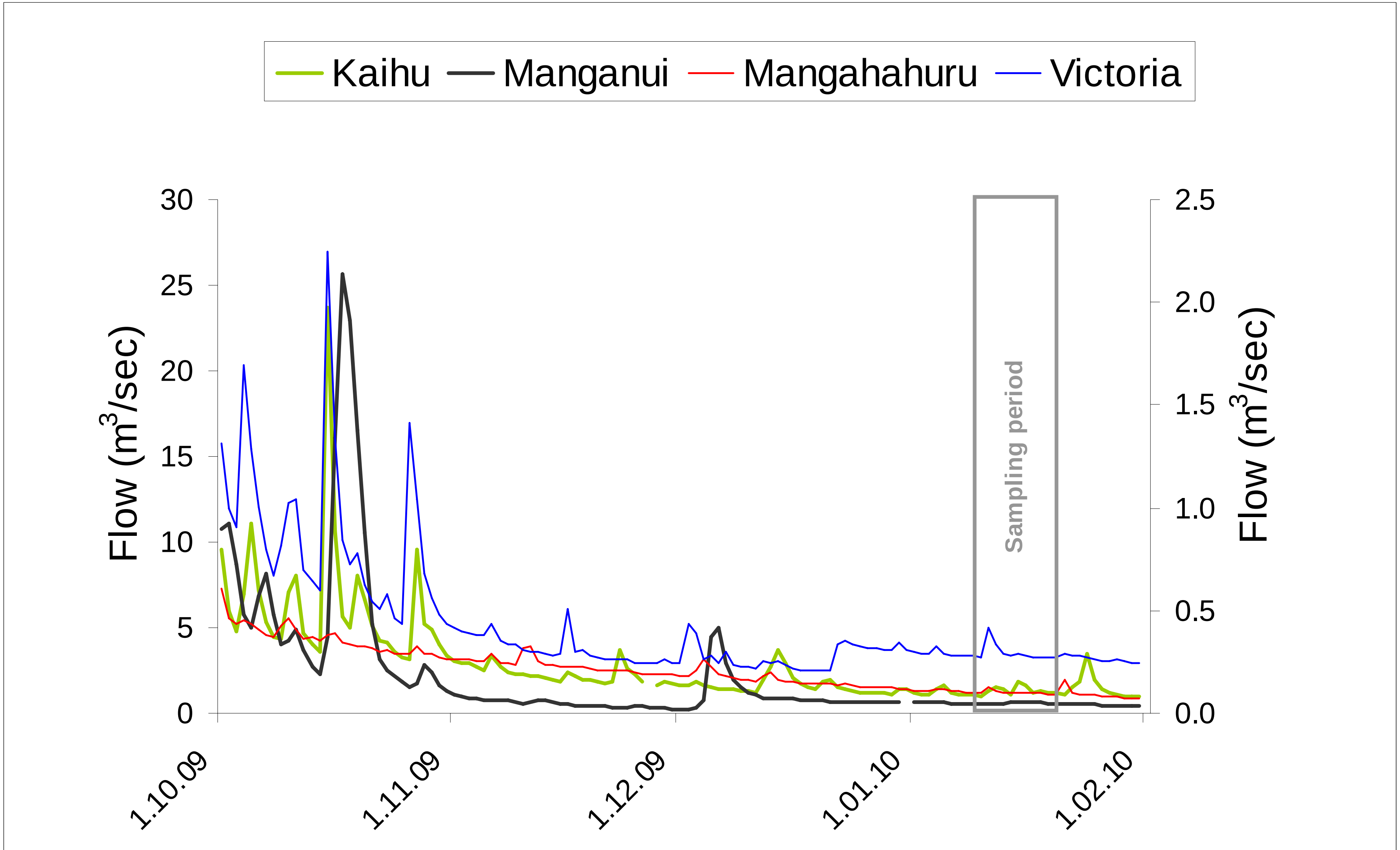

Figure 19. Select river flows (m^3/sec) across Northland prior to commencement of sampling. For Kaihu and Manganui (bold lines) refer to the primary axis and for Mangahahuru and Victoria (thin lines) refer to the secondary axis.

7. Appendix E

Table 6. Raw macroinvertebrate data for the State of Environment sites, Jan 2010. Sites in red have been reprocessed by an independent taxonomist as a measure of Quality Control.

Site name			Waiarohia @ Rust Ave Bridge	Waiarohia @ Russell Rd Bridge (Nth)	Waiarohia @ Kamo Tributary Culvert	Waiarohia @ Whau Valley Rd Bridge	Ngunguru @ Waipoka Rd	Awanui u/s Waihue Channel	Awanui @ FNDC watertake	Victoria @ Thompsons Bridge	Utakura @ Okaka Rd Bridge	Mangamuka @ Iwiatua Rd Bridge	Oruru @ Oruru Rd	Waipapa @ Forest Ranger	Waitangi @ Waimate Rd	Waitangi @ Watea	Kaeo River @ Dip Rd Bridge	Waipapa @ Waipapa Landing
Site number			**105672**	**105674**	**105677**	**107773**	**109100**	**100370**	**100363**	**105532**	**109020**	**108978**	**108979**	**101751**	**103178**	**101752**	**102674**	**101524**
Collection date			**10.01.10**	**10.01.10**	**10.01.10**	**10.01.10**	**10.01.10**	**18.01.10**	**18.01.10**	**18.01.10**	**19.01.10**	**18.01.10**	**18.01.10**	**19.01.10**	**17.01.10**	**13.01.10**	**18.01.10**	**13.01.10**
TAXA	Tolerance Values																	
INSECTA	HB	SB [1]																
Ephemeroptera																		
Acanthophlebia	7	9.6		1										1				
Ameletopsis	10	10.0										1			1			
Atalophlebioides	9	4.4																
Austroclima	9	6.5																
Austronella [1]	7	4.7																
Coloburiscus	9	8.1		1		1				20		5		20	1			
Deleatidium	8	5.6	20	20		100			5	20		100		100				
Mauiulus	5	4.1						1	20	1			1	1				
Neozephlebia	7	7.6								1								
Nesameletus	9	8.6																
Rallidens	9	3.9								1								
Zephlebia	7	8.8		5		5		1	5	1	5		1		100			
Plecoptera																		
Stenoperla	10	9.1																
Zelandobius	5	7.4										1		1				
Megaloptera																		
Archichauliodes	7	7.3	1	5		1				5		1		5				
Odonata																		
Adversaeshna	5	1.4													1			
Antipodochlora	6	6.3																
Xanthocnemis	5	1.2									5				20	1	1	5
Hemiptera																		
Anisops	5	2.2													1			
Microvelia	5	4.6					1								1			
Sigara	5	2.4						1							20	1	20	
Coleoptera																		
Antiporus	5	3.5													5			
Dytiscidae	5	0.4																
Elmidae	6	7.2	20	100		20			5	20		100		20	5			
Hydraenidae	8	6.7				1						1		1				
Hydrophilidae	5	8.0					1				1							
Ptilodactylidae	8	7.1																
Scirtidae	8	6.4																
Staphylinidae	5	6.2			1													
Diptera																		
Aphrophila	5	5.6	1	1														
Austrosimulium	3	3.9				1				5		1	1		5			
Chironominae [2]	**2.5**	**4.7**	5	1		100	1		100	100		20		100	100	1		
Empididae	3	5.4			1	1												
Eriopterini	9	7.5								1		5		5				
Harrisius	6	4.7																
Hexatomini	5	6.7			1				1			1						
Limonia	6	6.3			1													
Maoridiamesa	3	4.9																
Mischoderus	4	5.9							1									
Muscidae	3	1.6	5	1		1			1					5	1		1	1
Nothodixa	5	9.3									1							
Orthocladiinae	2	3.2	100	20	20	20		1	20	100		100		20	20	1		
Paradixa	4	8.5																
Stratiomyidae	5	4.2															1	
Tabanidae	3	6.8								1				1				
Tanypodinae	5	6.5							5	1		20		20	100		5	

Table 6 continued.

Site name			Waiarohia @ Rust Ave Bridge	Waiarohia @ Russell Rd Bridge (Nth)	Waiarohia @ Kamo Tributary Culvert	Waiarohia @ Whau Valley Rd Bridge	Ngunguru @ Waipoka Rd	Awanui u/s Waihue Channel	Awanui @ FNDC watertake	Victoria @ Thompsons Bridge	Utakura @ Okaka Rd Bridge	Mangamuka @ Iwiatua Rd Bridge	Oruru @ Oruru Rd	Waipapa @ Forest Ranger	Waitangi @ Waimate Rd	Waitangi @ Watea	Kaeo River @ Dip Rd Bridge	Waipapa @ Waipapa Landing
Trichoptera																		
Aoteapsyche	4	6.0	100	5		100			5	20		5		100	1			
Costachorema	7	7.2																
Ecnomina / Zelandoptila	8	**8.3**																
Helicopsyche	10	8.6																
Hudsonema	6	6.5		100		20			1			5		5				
Hydrobiosis	5	6.7	5	5		5			5	5		5		20	5			
Hydrochorema	9	**9.0**										1						
Hydroptilidae [2]	2	**2.5**																
Neurochorema	6	6.0												1				
Oecetis [1]	6	6.8				1									1			
Olinga	9	7.9										5		20				
Orthopsyche	9	7.5				1												
Oxyethira	2	1.2	20	20		20		20	5	5			1	20	100	1	1	1
Paroxyethira	2	3.7														1	5	5
Plectrocnemia	8	6.6																
Polyplectropus	8	8.1				1									1			
Psilochorema	8	7.8				1			1	1		1		5	5			
Pycnocentria	7	6.8							20	5		1			5			
Pycnocentrodes	5	3.8	5	100		5			5	20		5		20				
Triplectides	5	5.7			1	1	1	1				1	1	1	20	5	20	20
Lepidoptera																		
Hygraula	4	1.3											1					1
Collembola	6	5.3													1	1		
Acarina	5	5.2		5		5				1		1		5			1	1
CRUSTACEA																		
Amarinus [1]	**3**	5.1		1				1										
Amphipoda	5	5.5	100	5		100	20									5		
Cladocera	5	0.7													5			500
Copepoda	5	2.4																
Mysidae [1]	**5**	6.4					20											
OSTRACODA	3	1.9	100	20		100				1	1	1			20	20		
Paranephrops	5	8.4																
Paratya	5	3.6					100	100	20		100		100				100	100
MOLLUSCA																		
Ferrissia	3	2.4	1	5												1		1
Gyraulus	3	1.7	20	5	5													
Hyridella	3	6.7														1		
Latia	3	6.1																
Lymnaeidae	3	1.2													1	1		
Melanopsis	3	1.9					5						20					5
Physa	3	0.1	1	5				1							20	20	1	
Potamopyrgus	4	2.1	20	100	20	20	500	100	20	1	20	5	500	1	20	20	100	500
Sphaeriidae	3	2.9									1					1		1
HIRUDINEA	3	1.2	1	1														1
NEMERTEA	3	1.8		1								1				1		
OLIGOCHAETA	1	3.8	1	20	1	1			1									
PLATYHELMINTHES	3	0.9	1	1		1												
Total (Minimum) coded abundances (c_i)			527	554	51	633	649	227	246	336	134	393	626	498	586	82	256	1142
Taxonomic richness			20	27	9	27	9	10	20	23	8	26	9	25	29	17	12	14
MCI value			77.5	87.0	75.6	101.9	87.8	82.0	94.5	109.1	92.5	117.3	84.4	110.8	101.0	70.0	81.7	74.3
MCI-sb value			72.5	87.1	91.3	105.2	94.4	72.6	102.6	110.2	94.5	120.0	72.4	116.2	89.4	61.2	62.5	49.6
SQMCI value			3.72	4.82	3.14	4.48	4.21	4.27	3.85	3.79	4.90	5.30	4.13	5.11	4.18	3.53	4.52	4.53
SQMCI-sb value			4.03	4.57	2.91	4.69	2.59	2.75	4.58	4.75	3.54	5.46	2.35	5.52	4.59	2.13	3.11	1.68
EPT* count			4	8	1	12	1	3	9	11	1	13	3	13	10	1	1	1
%EPT*			20.0	29.6	11.1	44.4	11.1	30.0	45.0	47.8	12.5	50.0	33.3	52.0	34.5	5.9	8.3	7.1

* Excludes *Oxyethira* & *Paroxyethira* (Hydroptilidae) [1] Addition from Stark & Maxted (2007). [2] Further additions to list. **Bold** tolerance values are additional values assigned based on professional judgement or hard-bottomed tolerances.

Table 6 continued.

Site name			Kerikeri @ stone store bridge	Whaka-para @ cableway	Manga-hahuru @ Apotu Rd Bridge	Manga-hahuru @ end of Main Rd	Wairua @ Purua	Waipao @ Draffin Rd	Mangere @ Knight Rd Bridge	Manga-kahia @ Titoki Bridge	Opouteke @ suspension bridge	Manga-kahia ds of Twin Bridges	Punakitere @ Taheke Recorder	Waiotu @ SH1 Bridge	Kaihu @ gorge	Waipoua @ SH12 Rest Area	Waima-maku @ SH12	Manganui @ Mitaitai Rd	Ruakaka @ Flyger Road	Hakaru @ Topuni Creek Farm	Paparoa @ walking bridge	Hatea River u/s Mair Park Bridge	Waiharakeke Stream @ Stringers Rd Bridge
Site number			**101530**	**102249**	**100281**	**100237**	**101753**	**108941**	**101625**	**101038**	**102258**	**109096**	**105231**	**102248**	**102256**	**103304**	**109098**	**102257**	**105008**	**109021**	**108977**	**100194**	**100007**
Collection date			13.01.10	17.01.10	10.01.10	10.01.10	09.01.10	09.01.10	09.01.10	09.01.10	14.01.10	14.01.10	19.01.10	17.01.10	19.01.10	19.01.10	19.01.10	11.01.10	11.01.10	11.01.10	11.01.10	12.01.10	13.01.10
TAXA	Tolerance Values																						
INSECTA	HB	SB [1]																					
Ephemeroptera																							
Acanthophlebia	7	9.6														5							
Ameletopsis	10	10.0														1							
Atalophlebioides	9	4.4														5							
Austroclima	9	6.5				1																	1
Austronella [1]	7	4.7																	1				1
Coloburiscus	9	8.1				20		1			1				1	20	5						
Deleatidium	8	5.6				20					5				5	20	5						
Mauiulus	5	4.1		1		20		20			5	1				1	1						1
Neozephlebia	7	7.6																	1	1			
Nesameletus	9	8.6														100							
Rallidens	9	3.9									1	1				5							
Zephlebia	7	8.8	5	20	5	5	1	20	20	100		5	20		5	1	1		5	5			20
Plecoptera																							
Stenoperla	10	9.1														1							
Zelandobius	5	7.4																					
Megaloptera																							
Archichauliodes	7	7.3				5					1	5	1		5	5	1		1			1	
Odonata																							
Antipodochlora	6	6.3														1							
Xanthocnemis	5	1.2		1	5				5					20				5					
Hemiptera																							
Microvelia	5	4.6			1													1					
Sigara	5	2.4			1		1		1				5	1									
Coleoptera																							
Antiporus	5	3.5							1														
Dytiscidae	5	0.4							1														
Elmidae	6	7.2	1	1		20					5	1	20			5	5		1			1	1
Hydraenidae	8	6.7				5																	
Hydrophilidae	5	8.0			1					1													
Ptilodactylidae	8	7.1				1																	
Scirtidae	8	6.4														1							
Diptera																							
Aphrophila	5	5.6				1									5	5				1			
Austrosimulium	3	3.9		20		5		5			1				5		5						
Chironominae [2]	**2.5**	**4.7**	5	5	20	1		5		1	5	20	100		500		20			100		1	5
Corynoneura	2	1.7							1														
Empididae	3	5.4													1								
Eriopterini	9	7.5				5																	
Harrisius	6	4.7																					1
Hexatomini	5	6.7				1										1							
Maoridiamesa	3	4.9									5				5					5			
Muscidae	3	1.6									1	1			1		5			1			
Orthocladiinae	2	3.2	1	100	100		1	20	20	1	100	20	5		100	5	100			100		1	5
Paradixa	4	8.5			5				5	1								1					
Tanypodinae	5	6.5						1		5		5	5	1		5							

Table 6 continued.

Site name			Kerikeri @ stone store bridge	Whaka-para @ cableway	Manga-hahuru @ Apotu Rd Bridge	Manga-hahuru @ end of Main Rd	Wairua @ Purua	Waipao @ Draffin Rd	Mangere @ Knight Rd Bridge	Manga-kahia @ Titoki Bridge	Opouteke @ suspension bridge	Manga-kahia ds of Twin Bridges	Punakitere @ Taheke Recorder	Waiotu @ SH1 Bridge	Kaihu @ gorge	Waipoua @ SH12 Rest Area	Waima-maku @ SH12	Manganui @ Mitaitai Rd	Ruakaka @ Flyger Road	Hakaru @ Topuni Creek Farm	Paparoa @ walking bridge	Hatea River u/s Mair Park Bridge	Waiharakeke Stream @ Stringers Rd Bridge
Trichoptera																							
Aoteapsyche	4	6.0	20			5					100	5			20	5	100			100		5	1
Costachorema	7	7.2									1				1								
Ecnomina / Zelandoptila	8	**8.3**																					1
Helicopsyche	10	8.6														20							
Hudsonema	6	6.5		5				1	1	5		1	5			5			5	1		5	5
Hydrobiosis	5	6.7		5		1		5			5	1			5	5	1			1			
Hydroptilidae [2]	2	**2.5**												5				1					
Neurochorema	6	6.0				1									5	1	1						
Oecetis [1]	6	6.8						1					1										
Olinga	9	7.9														20							1
Orthopsyche	9	7.5																	1				
Oxyethira	2	1.2	5	20	20			20	20	5	20	20	5		1	5	100			5			
Paroxyethira	2	3.7		5	20		1		1	1		1											
Plectrocnemia	8	6.6														5							
Polyplectropus	8	8.1											1										
Psilochorema	8	7.8				1										1			1				
Pycnocentria	7	6.8		1				20		1													
Pycnocentrodes	5	3.8	5	20		5		20			5	5	20		5	1	100			5		20	1
Triplectides	5	5.7		1	5		1	1	20	20			1	5		5			20	1		5	20
Lepidoptera																							
Hygraula	4	1.3		1																			
Acarina	5	5.2			1				1						1	1	5		1				
CRUSTACEA																							
Amarinus [1]	**3**	5.1			1		1	1	5	1				1								1	
Amphipoda	5	5.5					20	100	100	100					100	1		5	500	20	100	20	
Cladocera	5	0.7			1									5									
Copepoda	5	2.4																			1		1
Mysidae [1]	**5**	6.4								1											20		
OSTRACODA	3	1.9			1											1				5			
Paranephrops	5	8.4								1													
Paratya	5	3.6	20							5		1					1		100	1	20	20	1
MOLLUSCA																							
Ferrissia	3	2.4	1				1				1			5	5			1					
Latia	3	6.1	1	1		5						1	5		5	1				1		1	1
Lymnaeidae	3	1.2			20																		
Melanopsis	3	1.9	5																			1	
Physa	3	0.1			5				1					1									
Potamopyrgus	4	2.1	20	100	100	20	500	20	500	500	20	20	100	500	100	5	100	500	20	20	500	20	20
Sphaeriidae	3	2.9			1																		
HIRUDINEA	3	1.2											1										
NEMERTEA	3	1.8	1								1		1		5					1			
OLIGOCHAETA	1	3.8											1		1	1	1			1		5	
PLATYHELMINTHES	3	0.9											5			1							
Total (Min) coded abundances (c_i)			90	307	313	148	527	261	703	749	283	114	302	544	887	271	557	514	657	375	641	107	87
Taxonomic richness			13	17	19	21	9	17	17	17	19	18	19	10	24	36	19	7	13	20	5	15	18
MCI value			76.2	86.5	77.4	120.5	80.0	95.9	82.4	87.6	95.3	91.7	87.9	80.0	87.9	121.7	94.2	80.0	124.6	80.5	96.0	82.0	109.4
MCI-sb value			81.2	90.6	74.9	122.2	86.4	105.3	76.2	111.4	90.2	96.7	92.7	57.4	97.4	118.7	97.8	76.6	122.3	91.1	80.0	96.7	107.0
SQMCI value			4.16	3.43	3.02	6.21	4.04	4.70	4.14	4.57	3.31	3.46	3.88	4.03	3.10	7.86	3.51	4.02	5.01	3.13	4.22	4.55	5.11
SQMCI-sb value			3.96	3.34	2.87	5.70	2.26	4.85	2.95	3.66	4.27	3.77	4.12	2.10	4.39	7.27	3.45	2.14	5.16	4.52	2.81	4.16	5.39
EPT* count			3	7	2	10	2	9	3	4	8	7	6	1	8	20	8	0	7	7	0	4	10
%EPT*			23.1	41.2	10.5	47.6	22.2	52.9	17.6	23.5	42.1	38.9	31.6	10.0	33.3	55.6	42.1	0.0	53.8	35.0	0.0	26.7	55.6

* Excludes *Oxyethira* & *Paroxyethira* (Hydroptilidae) [1] Addition from Stark & Maxted (2007). [2] Further additions to list. **Bold** tolerance values are additional values assigned based on professional judgement or hard-bottomed tolerances.

7. Appendix F

Table 7. Raw macroinvertebrate data for the Resource Consent sites, Jan 2010. Sites in red have been reprocessed by an independent taxonomist as a measure of Quality Control.

Site name			Dam d/s	Dam u/s	Oxidation Pond A d/s	Oxidation Pond A u/s	Meatworks d/s	Meatworks u/s	Oxidation Pond B d/s	Oxidation Pond B u/s	Quarry d/s	Quarry u/s	Farm catchment d/s	Farm catchment u/s
Site number			**106508**	**106509**	**100280**	**100279**	**100010**	**100007**	**103317**	**103316**	**103824**	**103823**	**108706**	**108705**
Collection date			**14.01.10**	**14.01.10**	**10.01.10**	**10.01.10**	**13.01.10**	**13.01.10**	**14.01.10**	**14.01.10**	**18.01.10**	**18.01.10**	**11.01.10**	**11.01.10**
TAXA	Tolerance Values													
INSECTA	HB	SB [1]												
Ephemeroptera														
Acanthophlebia	7	9.6		1										
Austroclima	9	6.5	1	1				1						
Austronella [1]	7	4.7						1			1			
Coloburiscus	9	8.1	1	20					5	1				
Deleatidium	8	5.6	1	100					1	1				
Mauiulus	5	4.1						1			1	1		
Neozephlebia	7	7.6		1										
Nesameletus	9	8.6									1			
Zephlebia	7	8.8		5	1	1	100	20	1	5				
Plecoptera														
Megaleptoperla	9	7.3		1										
Megaloptera														
Archichauliodes	7	7.3		5					1	1		1		
Odonata														
Austrolestes	6	0.7											5	1
Hemicordulia	5	0.4									1	1	1	5
Xanthocnemis	5	1.2			5	1					1	1	20	20
Hemiptera														
Microvelia	5	4.6											1	
Sigara	5	2.4			1								5	
Coleoptera														
Elmidae	6	7.2	1	5				1	1	5	1	5		
Hydrophilidae	5	8.0			1							1		
Rhantus	5	1.0			5									
Staphylinidae	5	6.2	1								1	1		
Diptera														
Austrosimulium	3	3.9	1	20		5				1	5	5		
Chironominae [2]	**2.5**	**4.7**	1	1	100		1	5	5	5	100	100	5	100
Corynoneura	2	1.7				1								
Culex	3	**3.0**												1
Eriopterini	9	7.5		1										
Harrisius	6	4.7						1						
Hexatomini	5	6.7		5										
Limonia	6	6.3							1					
Mischoderus (Tanyderidae)	4	5.9							1		1	1		
Muscidae	3	1.6		1					1			1		
Orthocladiinae	2	3.2	1	100	100	20		5	100	1	5	20		
Paradixa	4	8.5				1								
Psychodidae	1	6.1			1									
Tanypodinae	5	6.5					1	5		5	1			1

Table 7 continued.

Site name			Dam d/s	Dam u/s	Oxidation Pond A d/s	Oxidation Pond A u/s	Meatworks d/s	Meatworks u/s	Oxidation Pond B d/s	Oxidation Pond B u/s	Quarry d/s	Quarry u/s	Farm catchment d/s	Farm catchment u/s
Trichoptera														
Aoteapsyche	4	6.0	5	5				1	100		1			
Ecnomina / Zelandoptila	8	**8.3**						1						
Hudsonema	6	6.5	1				1	5		5				
Hydrobiosis	5	6.7	5	20					5		1	1		
Hydroptilidae [2]	2	**2.5**					1						1	
Olinga	9	7.9						1						
Orthopsyche	9	7.5									5	5		
Oxyethira	2	1.2	20	5	1	5						20		
Paroxyethira	2	3.7			1	1								
Polyplectropus	8	8.1	5							1				
Psilochorema	8	7.8	1						1					
Pycnocentria	7	6.8									1	5		
Pycnocentrodes	5	3.8						1		20				
Triplectides	5	5.7	1	1	1	5	20	20		20	20	20	20	
Collembola	6	5.3		1										
Acarina	5	5.2	5						1		1	1		
<u>CRUSTACEA</u>														
Amarinus [1]	**3**	5.1			5		1							
Amphipoda	5	5.5	1	1			100				1			
Cladocera	5	0.7			20		500						500	20
Copepoda	5	2.4						1						
OSTRACODA	3	1.9								1			20	5
Paratya	5	3.6					20	1					100	
<u>MOLLUSCA</u>														
Ferrissia	3	2.4			20	1			1		1	5		
Glyptophysa	5	0.3				1								
Gyraulus	3	1.7											100	100
Latia	3	6.1						1						
Lymnaeidae	3	1.2			20									
Physa	3	0.1			5						1		5	1
Potamopyrgus	4	2.1	20	5	20	500	500	20	5	20	20	20	100	20
Sphaeriidae	3	2.9	1											
HIRUDINEA	3	1.2											1	5
<u>NEMERTEA</u>	3	1.8								1				
OLIGOCHAETA	1	3.8	20						20	20	1	1		
<u>PLATYHELMINTHES</u>	3	0.9												5
Total (Minimum) coded abundances (c_i)			93	305	307	542	1245	92	250	113	172	216	884	284
Taxonomic richness			20	22	17	12	11	19	17	17	23	21	15	13
MCI value			100.5	113.2	73.5	73.3	90.0	108.9	99.4	99.4	95.2	89.0	82.0	77.7
MCI-sb value			106.9	116.5	67.8	71.2	94.0	108.2	109.1	104.7	94.3	90.6	44.7	38.6
SQMCI value			3.46	5.17	2.79	3.91	4.75	5.10	3.12	4.21	3.40	3.24	4.59	3.23
SQMCI-sb value			3.72	4.96	3.23	2.20	2.44	5.45	4.65	4.57	4.54	4.18	1.49	2.65
EPT* count			9	10	2	2	3	10	6	7	8	5	1	0
%EPT*			45.0	45.5	11.8	16.7	27.3	52.6	35.3	41.2	34.8	23.8	6.7	0.0

* Excludes *Oxyethira* & *Paroxyethira* (Hydroptilidae) [1] Addition from Stark & Maxted (2007). [2] Further additions to list. **Bold** tolerance values are additional values assigned based on professional judgement or hard-bottomed tolerances.