NORTHLAND MACROINVERTEBRATE MONITORING PROGRAMME

2009 Monitoring Report

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Cover photo:

One of the State of the Environment monitoring sites, located north of Wellsford.

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Synopsis

This report presents results of the 2009 round of the Northland Macroinvertebrate Monitoring Programme, carried out by Pohe Environmental for the Northland Regional Council (NRC). Thirty-seven State of Environment (SoE) sites and ten Resource Consent (RC) sites were assessed throughout Northland. This report also presents the 2009 results with results of previous monitoring undertaken from 1997 (biannual 1997–2002, annual thereafter), looking at trends in the main biotic indices.

Forty-six benthic samples were taken using the sampling protocols developed by the New Zealand Macroinvertebrate Working Group. 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 2009 monitoring programme, in approximately equal proportions (24 hard-bottomed and 22 soft-bottomed).

Data was 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, Waipapa River @ Forest Road, Victoria River @ Thompson's Bridge, Mangamuka River @ Iwiatua Road Bridge (all SoE sites), and the Dam upstream site (RC) recorded clean water this year, based on MCI and/or SQMCI results. These were the same 'top' five sites as last year.

Fifty-nine percent 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 22% of sites were recorded in the 'moderate pollution' interpretation. The worst of the SoE sites for 2009, based on MCI and SQMCI results were (worst site first):

- Waitangi @ Watea,
- Wairua @ Purua,
- Utakura @ Okaka Rd Bridge, and
- Waiarohia @ Kamo Tributary Culvert.

The worst of the RC sites for 2009, based on MCI and SQMCI results were:

- Oxidation Pond A u/s
- Oxidation Pond A d/s

Also of concern, though not as obvious from the results, were Ngunguru @ Waipoka Rd, Paparoa @ walking bridge, and Manganui @ Mitaitai Rd. These sites contained low diversity communities, and the use of MCI values for these should be treated with caution. If there are a low number of taxa, the average sensitivity score becomes less reliable.

When considering the MCI and SQMCI trend results collectively, 13 (40.5%) of the 32 sites analysed indicated a reduction in their biotic index. A further 13 (40.5%) sites indicated little change. Only six sites (19%) indicated an increase in their biotic index, though two of these were not convincing. The following five sites indicated the most apparent decreasing trends, though no statistical tests were undertaken:

- Quarry upstream
- Quarry downstream
- Mangere @ Knight Rd Bridge
- Waiarohia @ Whau Valley Rd Bridge
- Opouteke @ suspension bridge

Contents

1. Introduction

This report presents the results of the 2009 round of the Northland Macroinvertebrate Monitoring Programme, carried out by Pohe Environmental for the Northland Regional Council (NRC). Thirty-seven State of Environment (SoE) sites and ten Resource Consent (RC) sites were assessed throughout Northland (Fig. 1). This report also presents the 2009 results with results of previous monitoring undertaken from 1997 (biannual 1997–2002, annual thereafter), looking at trends in the main biotic indices.

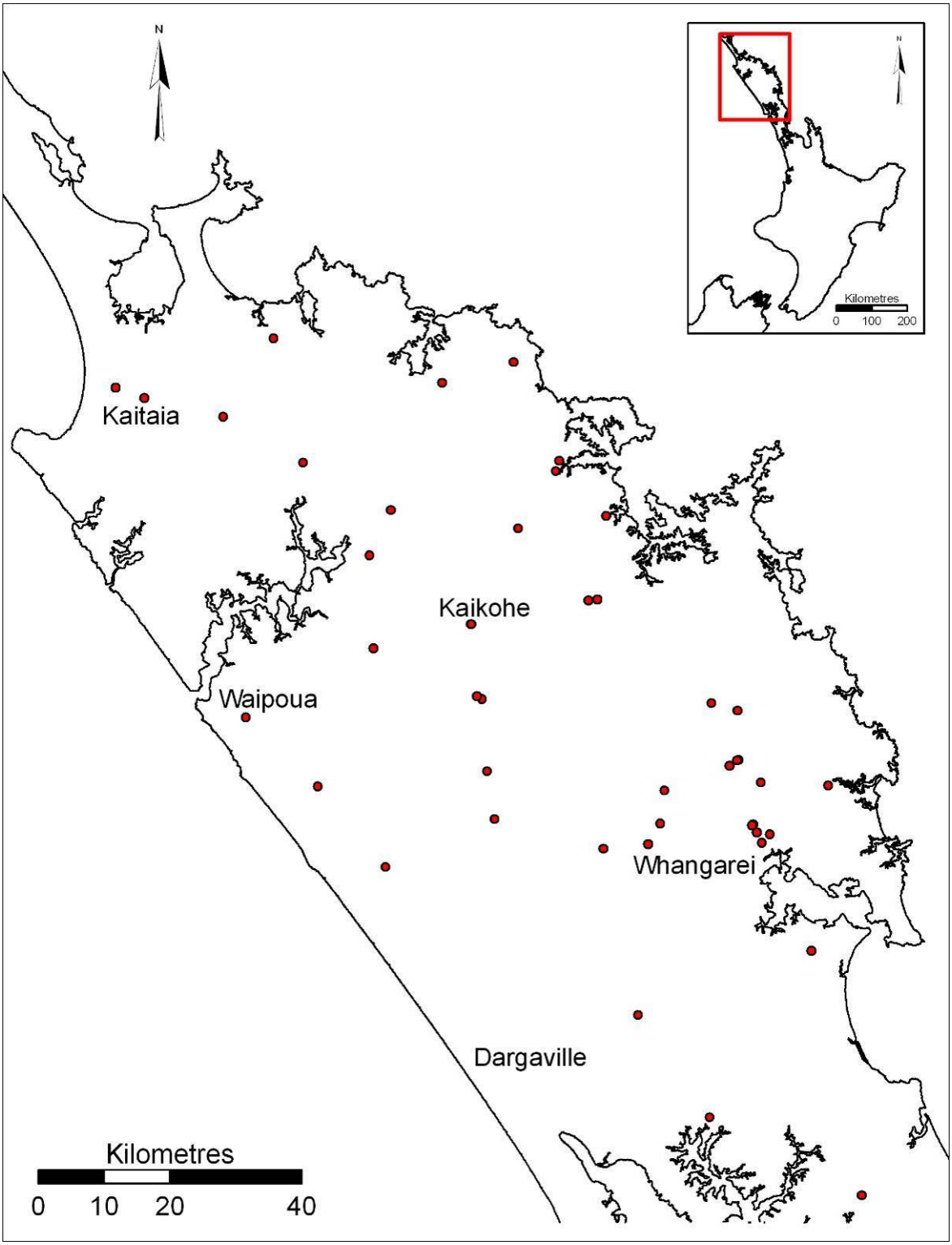

Figure 1. Location of the 47 sites assessed during the 2009 Macroinvertebrate Monitoring Programme. Note that several sampling points are hidden by other sampling points.

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 i.e. 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 i.e. 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). The most recent publications (Stark & Maxted 2004, 2007a) added revised tolerance scores for taxa collected from soft-bottomed sites; the resulting MCI and SQMCI scores being labelled MCI-sb and SQMCI-sb. The Northland Regional Council has acknowledged the usefulness of this publication 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-six 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 2009 monitoring programme, in approximately equal proportions (24 hard-bottomed and 22 soft-bottomed).

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, 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 10.6% of samples was carried out by an independent taxonomist following the QC1 protocol of Stark *et al*. (2001). Specimens were recorded to the level required by the protocol. Results of quality controlled samples are presented in Appendix A and differ slightly from those presented in the resurlts due to minor differences in 'Abundance-coding 1' and 'Abundance-coding 2'. Values are within the accepted ranges outlined by the protocol.

2.1.3 Habitat assessments and periphyton (P) analysis

Habitat assessments are scheduled for every other year and were not required this year. Periphyton samples (four replicates instead of ten as suggested in the method) were collected following the Quantitative method 1b of Biggs & Kilroy (2000) from suitable hard-bottomed sites (18) selected by NRC; data is to be presented by NRC in a separate report or database.

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). Flow (m/s) was measured using a Global Water Flow Probe. A water sample was collected in the field, stored in an iced chilly-bin, and used to obtain a pH reading on return to the laboratory (within 8 hours), using a Denver bench-top pH meter (Model 215). All physico-chemical water measurements are presented in Appendix B.

2.2 Sampling locations

Several changes were made to the Macroinvertebrate Monitoring Programme this year. One new SoE site was established (Hatea River u/s Mair Park Bridge) and two were removed (Mangakahia River u/s of Twin Bridges and Otarao Stream near Mangakahia River). Waiharakeke Stream @ Stringers Road has been made a permanent SoE site; data being derived from a RC site. All sites were consisted be the same streambed composition as was encountered in 2008. Tables 1 and 2 present the locations and details of the 37 SoE and 5 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	C1, 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	1726626	6029623	C2, MCI-sb
109020[1]	Utakura River @ Okaka Road Bridge	1659427	6089576	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	1718284	6047585	C1, MCI
105672	Waiarohia Stream @ Rust Ave Bridge (P)	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 10 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 (P)	1681183	6119003	C1, MCI

Figure 2. Hard-bottomed site on the Waipapa River.

Figure 3. Soft-bottomed site on the Manganui River.

Figure 4. Lowland site in Paparoa.

Figure 5. Upper-catchment site from Kamo, Whangarei.

2.3 Sampling period

Samples were collected in April this year (06–16/04/09) due to heavy rain events in late February and early March (see Appendix C for select river flows prior to sampling). All samples were collected during stable weather conditions and approximately base-flow levels.

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 proportion of these orders that are 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 i.e. $\sum (c_i \times a_i) / M$ (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.