NORTHLAND MACROINVERTEBRATE MONITORING PROGRAMME

2008 Monitoring Report

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TAI TOKERAU WĀNANGA

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Cover photo:

One of the State of the Environment monitoring sites, located near the Kerikeri stone store.

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Synopsis

This report presents results of the 2008 round of the Northland Macroinvertebrate Monitoring Programme, carried out by NorthTec (Applied & Environmental Sciences) for the Northland Regional Council (NRC). Thirty-eight State of Environment sites and twelve Resource Consent sites were sampled throughout Northland. This report also compares the 2008 results with results of previous surveys undertaken from 1997 (biannual 1997–2002, annual thereafter), and presents trends in biotic indices.

Fifty 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 2008 monitoring programme, in equal proportions (25 hard-bottomed and 25 soft-bottomed).

Data obtained from the samples was entered into Microsoft Excel and 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.

The Waipoua River at the SH12 Rest Area, Waipapa River at the end of Forest Road, Victoria River at 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 SQMCI results.

Twenty-four percent of SoE sites recorded MCI scores which can be interpreted as water of probable severe 'organic' pollution and 33% of RC sites recorded MCI scores of 'probable severe pollution'. However, the general array of SQMCI results indicated lower-quality conditions than the MCI results, with 75% of sites recorded in (or just above) the 'probable severe pollution' class. Overall, a large percentage of the sites recorded either moderate or severe pollution levels, however many samples were difficult to collect this year due to steep banks, and lack of suitable habitat, possibly resulting from the severe flooding event in July 2007.

When considering the MCI and SQMCI trend results collectively, 26% of the sites analysed show no statistical change in stream health. A further 53% indicated a weak to modest statistical change (either negative or positive). Two sites (6%), Otarao near Mangakahia River, and Waipoua at SH12 Rest Area, showed a strong statistical increase in stream health. However, the following five (15%) sites all indicated a modest to strong statistical decrease in stream health:

- Waiarohia River at Whau Valley Rd
- Opouteke River at suspension bridge
- Waiotu River at SH1 Bridge
- Punakitere River at Taheke Recorder
- Quarry upstream

The first three sites listed above were also highlighted as a concern based on the 2007 monitoring programme results.

Other SoE sites of concern are the Waiarohia Stream @ Kamo tributary culvert, Mangere Stream @ Knight Road, and Kaihu River @ gorge, due to their low returning index scores. RC sites of concern are the Wood Processing and Oxidation Pond A sites, both the upstream and downstream. This suggests that the consented activities are probably not the immediate concern, however the waterway is of poor quality.

Contents

1. Introduction

This report presents the results of the 2008 round of the Northland Macroinvertebrate Monitoring Programme, carried out by NorthTec (Applied & Environmental Sciences) for the Northland Regional Council (NRC). Thirty-eight State of Environment sites and twelve Resource Consent sites were sampled throughout Northland (Fig. 1). This report also compares the 2008 results with results of previous surveys undertaken from 1997 (biannual 1997–2002, annual thereafter), and presents trends in biotic indices.

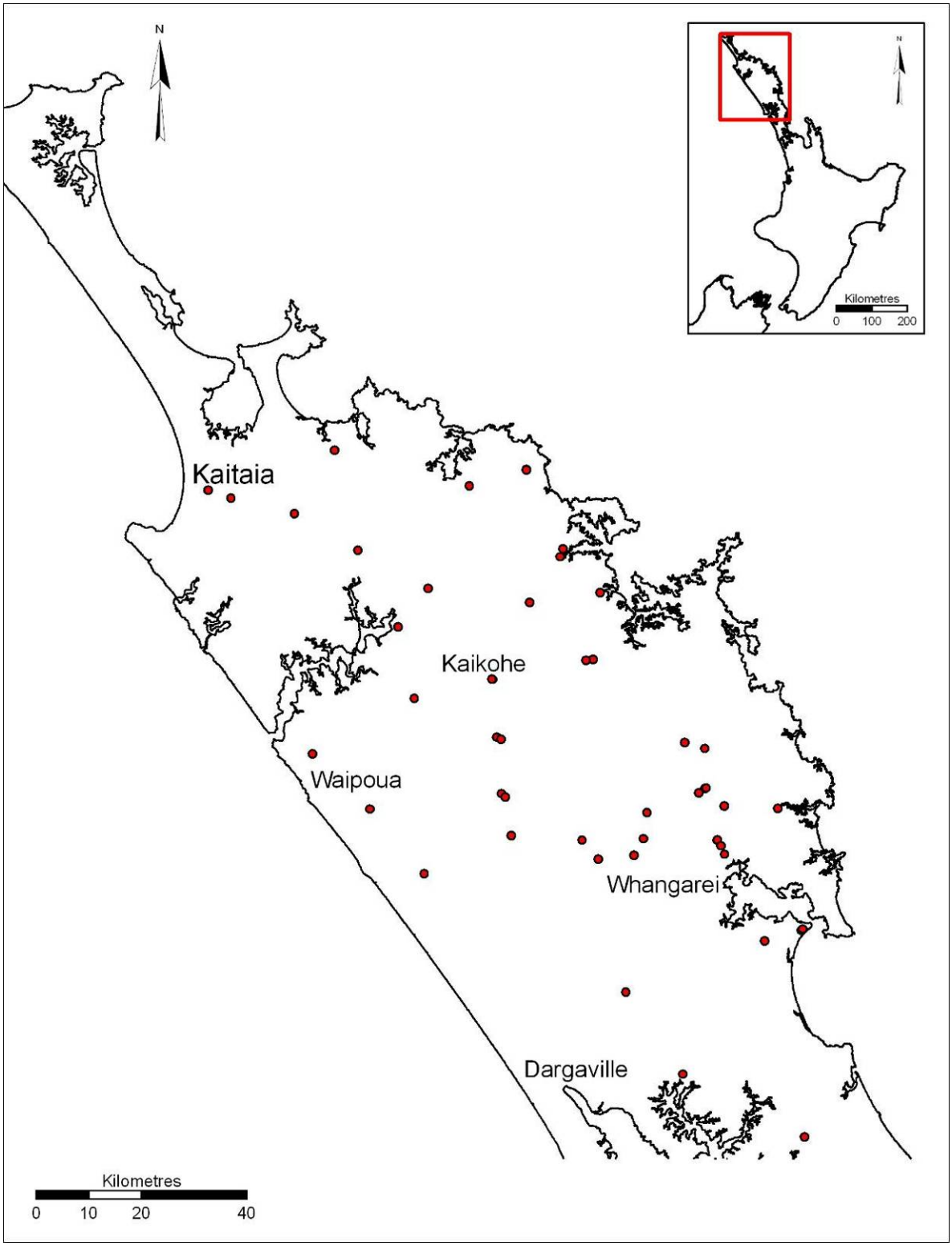

Figure 1. Location of the 50 sampling sites for the 2008 Macroinvertebrate Monitoring Programme. Note that several sampling points are hidden by other sampling points.

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). Recently, a new protocol (Stark & Maxted 2004, 2007a) has been published for soft-bottomed streams, and although it may be more suitable, has not been implemented in Northland yet.

2. Methods

2.1 Sampling protocol

2.1.1 Macroinvertebrate sampling

Fifty 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 2008 monitoring programme, in equal proportions (25 hard-bottomed and 25 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 marker pen. 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).

Several representatives of each taxon were retained from each sample to confirm identification by microscopic examination, and were stored in vials, as voucher specimens. Macroinvertebrates were identified to the taxonomic level required by 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 a MCI tolerance score of 2 assigned based on professional judgement (mean score of lower level taxon). 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% (5 samples) of the samples, were carried out by an independent taxonomist following the QC1 protocol of Stark *et al*. (2001). Specimens were recorded to at least the level required by the protocol, and sometimes beyond. Results of quality controlled samples are presented in appendix A. Results of the quality controlled samples differ slightly from those presented in this report, due to minor differences in 'Abundance-coding 1' and 'Abundance-coding 2', but are within the accepted difference outlined by the protocol. Note that a marked difference in taxonomic richness exists between some QC samples and is due to the high level of taxonomic resolution reported in the QC results e.g. Flatworms and Rhabdocoel Flatworms.

2.1.3 Habitat assessments

Habitat assessments were not carried out this year.

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). Water clarity was not measured this year. All physico-chemical water measurements are presented in appendix B.

2.2 Sampling locations

There have been several changes and additions to the Macroinvertebrate Monitoring Programme sites this year. Eleven new State of the Environment sites have been established this year, and one additional Resource Consent site (upstream and downstream of discharge). Waiharakeke Stream at Stringers Road Bridge has been included again as a SoE monitoring site; data being derived from a Resource Consent site. A dam sampling site was excluded from this years Resource Consent monitoring.

Three of the Macroinvertebrate Monitoring Programme sites, being Awanui at Far North District Council watertake, Kaeo River at Dip Road Bridge, and Waitangi River at Waimate Road, were different in streambed composition to what was encountered in 2007. As a result, these three sites were sampled using the protocol that matched the aquatic habitat present this year.

Tables 1 and 2 present the locations and details of the 38 State of the Environment and 6 Resource Consent monitoring sites, respectively. Each of the Resource Consent sites has an upstream and downstream sampling point. The monitoring sites contain a large range of physical conditions including large hard-bottomed rivers (Fig. 2), large soft-bottomed rivers (Fig. 3), small lowland streams (Fig. 4), and upper-catchment streams with native canopy (Fig. 5).

Table 1. Locations and details of the 38 State of the Environment sites throughout Northland, u/s = upstream, d/s = downstream.

NRC Site No.	Site name	GPS Coordinates		Sampling Protocol
		Easting	Northing	
100363	Awanui River @ FNDC watertake	1625095	6113439	C1
100370	Awanui River u/s of Waihue Channel	1620713	6114952	C2
109021	Hakaru River @ Topuni Creek Farm	1734330	5992416	C1
102674	Kaeo River @ Dip Road Bridge	1670326	6115833	C1
102256	Kaihu River @ gorge	1661946	6042161	C1
101530	Kerikeri River @ stone store bridge	1687631	6102447	C1
100281	Mangahahuru Stream @ Apotu Road Bridge	1714117	6057720	C2
100237	Mangahahuru Stream @ end of Main Road	1718886	6055192	C1
101038	Mangakahia River @ Titoki Bridge	1694999	6045028	C2
103307	Mangakahia River u/s of Twin Bridges	1676633	6057405	C1
109096	Mangakahia River d/s of Twin Bridges	1677333	6056762	C1
108978	Mangamuka River @ Iwiatua Road Bridge	1649247	6103622	C1
102257	Manganui River @ Mitaitai Road	1700359	6019751	C2
101625	Mangere Stream @ Knight Road	1703586	6048948	C2
109100	Ngunguru River @ Waipoka Road	1729072	6054775	C2
102258	Opouteke River @ suspension bridge	1678503	6049460	C1
108979	Oruru River @ Oruru Road	1644740	6122563	C2
107045	Otarao Stream near Mangakahia River	1691973	6048618	C2
108977	Paparoa Stream @ walking bridge	1711218	6004190	C2
105231	Punakitere River @ Taheke Recorder	1660001	6075453	C1
105008	Ruakaka River @ Flyger Road	1726626	6029623	C2
109020	Utakura River @ Okaka Road Bridge	1656910	6089081	C2
105532	Victoria River @ Thompsons Bridge	1637132	6110554	C1
105677	Waiarohia Stream @ Kamo tributary culvert	1717682	6048783	C1
105674	Waiarohia Stream @ Russell Road Bridge Nth	1718284	6047585	C1
105672	Waiarohia Stream @ Rust Ave Bridge	1719047	6046013	C1
107773	Waiarohia Stream @ Whau Valley Road	1717568	6048671	C1
100007	Waiharakeke Stream @ Stringers Road Bridge	1692604	6082806	C2
109098	Waimamaku River @ SH12	1640666	6064914	C1
102248	Waiotu River @ SH1	1711381	6067240	C2

108941	Waipao River @ Draffin Road	1701772	6045796	C2
101751	Waipapa River @ Forest Ranger	1662582	6096421	C1
101524	Waipapa River @ Waipapa Landing Bridge	1688150	6103986	C2
103304	Waipoua River @ SH12 Rest Area	1651633	6054443	C1
101753	Wairua River @ Purua	1704273	6053948	C2
101752	Waitangi River @ Watea	1695269	6095708	C2
103178	Waitangi River @ Waimate Road	1681894	6093741	C2
102249	Whakapara River @ cableway	1715259	6066116	C2

Table 2. Locations and details of the 12 Resource Consent sites throughout Northland, u/s = upstream, d/s = downstream.

NRC Site No.	Site name	GPS Coordinates		Sampling Protocol
		Easting	Northing	
106509	Dam u/s	1676506	6067761	C1
106508	Dam d/s	1675697	6068165	C1
100007	Meatworks u/s	1692604	6082806	C2
100010	Meatworks d/s	1693927	6082944	C2
103823	Quarry u/s	1681183	6119003	C1
103824	Quarry d/s	1681164	6118975	C1
100279	Oxidation Pond A u/s	1715480	6058620	C2
101280	Oxidation Pond A d/s	1715260	6058497	C2
103316	Oxidation Pond B u/s	1674725	6079148	C1
103317	Oxidation Pond B d/s	1674860	6079127	C1
108669	Wood Processing u/s	1733605	6031602	C2
108670	Wood Processing d/s	1733886	6031800	C2

Figure 2. Hard-bottomed site at Topuni.

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

Figure 4. Lowland site in Paparoa.

Figure 5. Upper-catchment site with native canopy cover, north of Whangarei.

2.3 Sampling period

Samples were collected during late January (23–29/01/08). Two additional samples, requested for compliance monitoring, were collected on 14/02/08. All samples were collected during stable weather conditions and base-flow levels. A moderate rain event moved across Northland on 21/01/08 raising levels briefly (1–4 times base-flow), but not to an intensity that effected the stream invertebrate communities. Southern sites received the largest flow increases (up to 4x) and southern samples were collected towards the end of the sample-collection period.

2.4 Data analysis

Data obtained from the samples was entered into Microsoft Excel and analysed in order to describe and compare the community assemblages, and consequently report on water quality at each site. Calculation of the following biotic indices was 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)
The Macroinvertebrate Community Index (MCI) was designed to assess organic enrichment and works by using the macroinvertebrates as biological indicators of water quality. It is based on the presence of macroinvertebrate taxa, which are each assigned scores reflecting their tolerance to environmental changes. These tolerance scores range between 1 and 10 (1 being highly tolerant, and 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, divided by the number of taxa, and multiplied by 20. 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'. 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 Semi-Quantitative Macroinvertebrate Community Index (SQMCI)
This is similar to the MCI, but also takes into account the number of individuals belonging to each taxon. Because of this, SQMCI is considered to be more accurate reflection of stream health than the MCI, when samples to be compared are collected within a relatively short temporal period. The resulting score is a number between 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'. As with the MCI, it is important to acknowledge the 'fuzzy' divisions between quality classes when interpreting the SQMCI. Stark & Maxted (2007b) suggest a buffer of ± 1.00 unit.