NORTHLAND MACROINVERTEBRATE MONITORING PROGRAMME

2012 Monitoring Report

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Cover photo:

State of the Environment site on the Wairua River at Purua west of Whangarei.

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Synopsis

This report presents results of the 2012 round of the Northland Macroinvertebrate Monitoring Programme, carried out by Pohe Environmental for the Northland Regional Council (NRC). This report also compares the 2012 results with results of previous monitoring undertaken from 1997 (biannual 1997–2002, annual thereafter), looking at trends in the main biotic indices. Thirty-eight State of Environment (SoE) sites and four Resource Consent (RC) locations (upstream and downstream sites) were assessed throughout Northland for 2012.

Forty-five 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 2012 monitoring programme using corresponding sampling protocols (26 C1 and 19 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. MCI and SQMCI data were transferred to the statistical package SigmaPlot 9.0 to produce LOWESS data points (tension of 0.4) for trend analysis.

Three SoE sites (7.9%), Waipoua @ SH12 Rest Area, Pukenui Stream u/s Ridge Track crossing and Mangahahuru @ end of Main Rd, recorded 'clean water' based on MCI and SQMCI results. Three further sites potentially fall into the MCI or SQMCI 'clean water' category if a buffer is considered. However, declining trends are observed for several of these 'top sites'. Twenty SoE sites (52.6%) recorded SQMCI scores ≤4.00, which is interpreted as water of probable 'severe pollution'. A further 11 sites (28.9%) were recorded in the 'moderate pollution' interpretation; **a total of 81.6% of sites in poorly polluted categories** (SQMCI <5.00).

The worst of the SoE sites for 2012, based on SQMCI results were:

- Waiarohia Stream @ Kamo Tributary Culvert
- Waitangi River @ Watea
- Utakura River @ Okaka Rd Bridge
- Waiotu River @ SH1 Bridge
- Oruru River @ Oruru Rd

These sites regularly feature at/near the bottom of the invertebrate monitoring programme and for most part, the reasons will be related to difficulties of sampling due to their large size combined with the nature of their position in their river continuum, effectively receiving nutrients from large agricultural catchments. One particular concern is the **Kamo Tributary Culvert site** on the Waiarohia Stream which has had poor biological scores since monitoring began however the surrounding environment, in-stream habitat, as well as physical water parameters, all appear excellent. This site was highlighted as a particular concern in the 2010 and 2011 monitoring reports and a member of the public also reported concerns in 2010. **Further investigation is strongly suggested.**

With regard to the consented activities (RC sites), the Meatworks activity, and to a lesser extent the Dam operation, showed considerable differences between the downstream and upstream SQMCI values. Regarding the Dam operation, index scores are most likely due to the retention of sediment at the downstream site which considerably impairs both the biological communities, and also the ability to collect comparable samples. In terms of general stream health (as opposed to testing upstream/downstream differences), the Oxidation Pond activity sites (both upstream and downstream) regularly record very poor index scores.

A 'shotgun' inspection of collective MCI and SQMCI index trends, for SoE sites, indicated that 19 of the 32 sites (59.4%) showed little ecological change. A further nine sites (28.1%) indicated a reduction in their biotic index over time and four sites (12.5%) indicated an increase in their biotic index over time. When looking at the trend results of MCI and SQMCI collectively, and loosely fitting them into the water quality classes, 65.6% of sites can be interpreted as 'probable moderate' or 'probable severe pollution', 28.1% of sites as 'mild pollution' and 6.3% as 'clean water'.

Contents

1. Introduction

This report presents results of the 2012 round of the Northland Macroinvertebrate Monitoring Programme, carried out by Pohe Environmental for the Northland Regional Council (NRC). This report also compares the 2012 results with results of previous monitoring undertaken from 1997 (biannual 1997–2002, annual thereafter), looking at trends in the main biotic indices. Thirty-eight State of Environment (SoE) sites and four Resource Consent (RC) locations (upstream and downstream sites) were assessed throughout Northland for 2012 (Fig. 1).

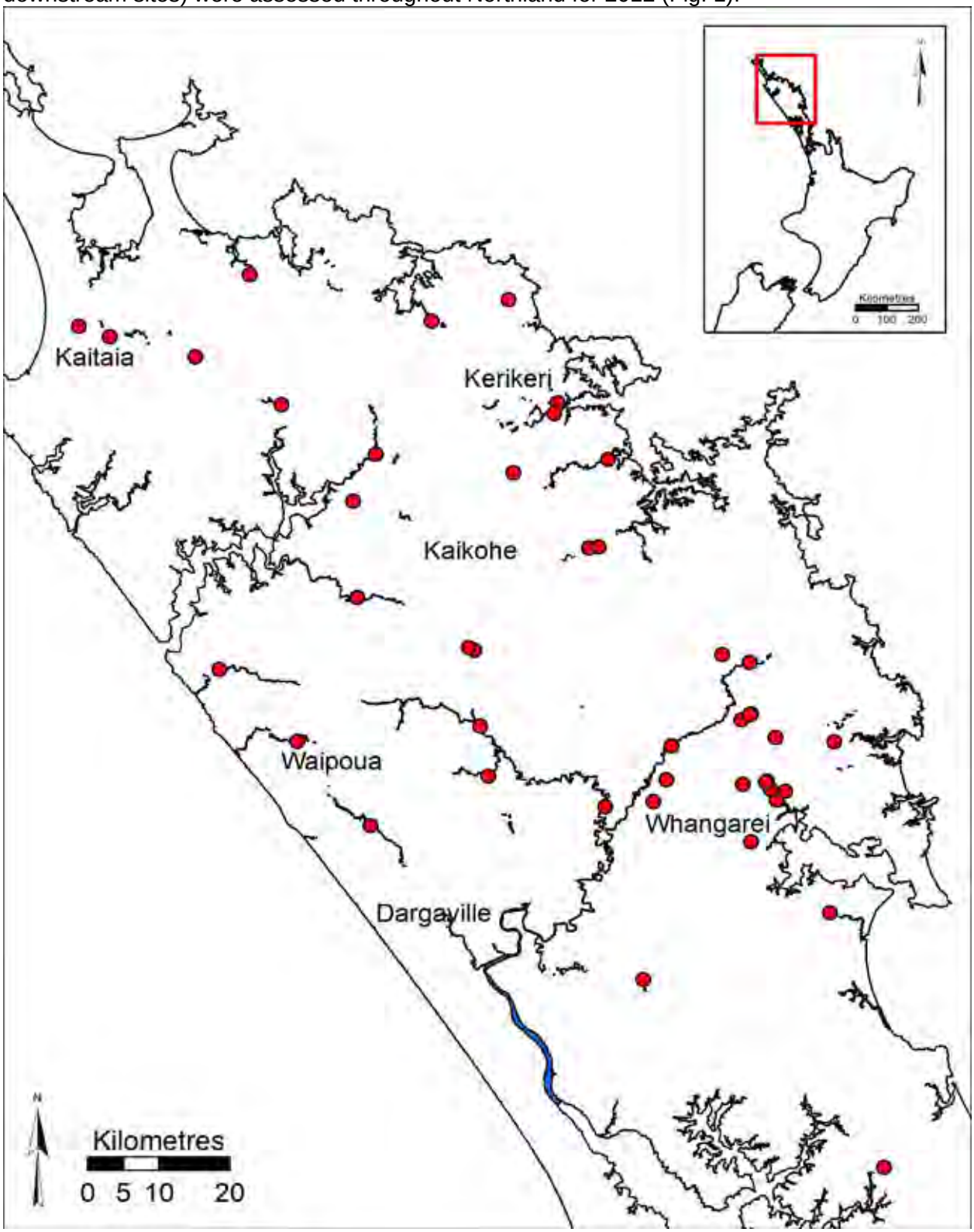

Figure 1. Location of the 45 sites visited during the 2012 Macroinvertebrate Monitoring Programme. Note that several sampling points are obscured by other sampling points.

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 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 advances 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-five benthic samples were taken (46 reported, see 2.2 for details) 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 2012 monitoring programme using corresponding sampling protocols (26 using C1 and 19 using C2).

Hard-bottomed sites were characterised as 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). 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 per subsample) and concentrated within the main substrate sizes to a depth of ~100mm (where possible), 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 0.3m^2 sub-samples) while moving progressively upstream. Sampling effort was of consistent intensity and area (ten 1m sweeps) 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 bucket, 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 (in some cases e.g., Leptophlebiidae and Hydrobiosidae, all specimens were checked), and 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 Chapman *et al*. (2011), Winterbourn *et al*. (2006), Towns & Peters (1996), Winterbourn (1973) and Smith & Ward (unpublished). 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 5 samples (11.1%) 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 were recorded, with values being well within the acceptable ranges outlined by the protocol. Voucher vials with recorded differences were rechecked by Pohe Environmental; we agree with all QC identifications and have incorporated ‘new taxa’ into the results. Initial abundance estimates made by Pohe Environmental were retained.

2.1.3 Habitat assessments and periphyton (P) analysis

Site habitat assessments for River Water Quality Monitoring Network sites (not consent sites) were also completed this year, by NRC staff. The next habitat assessments will be carried out during the summer of 2014. Periphyton samples (five replicates instead of ten as suggested in the method) were collected following the Quantitative method 1b of Biggs & Kilroy (2000) from 16 hard-bottomed sites selected by NRC (see Table 1, periphyton collection sites indicated with a ‘P’). 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) and temperature compensated conductivity (μS_{25}/cm). All physico-chemical water measurements are presented in Appendix C (Tables 4, 5).

2.2 Sampling locations

Ngunguru River @ Coalhill Lane and Otaika Stream @ Otaika Valley Rd were added to the SoE programme this year. Paparoa Stream @ walking bridge was removed. Two RC locations were removed (Oxidation Pond B and Farm Catchment). One SoE site (Waitangi River @ Waimate Road) was of a different streambed composition to that encountered 2008–2011 (but same as 2006 and 2007) due to bank scouring and lack of in-stream macrophytes. However, its index calculation remains unchanged. Tables 1 and 2 present the locations and details of the 38 SoE and four RC locations, respectively. Each of the RC locations had an upstream and downstream sampling site. Also, one RC site (Meatworks u/s) was included as a SoE site (as Waiharakeke Stream @ Stringers Road Bridge) i.e., a total of 45 samples collected, 46 results reported.

Table 1. Locations and details of the 38 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
110603	Ngunguru River @ Coalhill Lane	1727163	6054605	C1, MCI
102258	Opouteke River @ suspension bridge (P)	1678503	6049460	C1, MCI
108979	Oruru River @ Oruru Road	1644740	6122563	C2, MCI-sb
110431	Otaika Stream @ Otaika Valley Rd	1715476	6039940	C1, MCI
110370	Pukenui Stream u/s of Ridge Track crossing (P)	1714309	6048314	C1, MCI
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	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)	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 Stream @ 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 River @ Waimate Road	1681894	6093741	C1, 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 4 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	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
103824	Quarry d/s	1681164	6118975	C1, MCI
103823	Quarry u/s	1681183	6119003	C1, MCI

The Northland Invertebrate Monitoring Programme contains sites with a wide range of physical and geological conditions including large (20–30m wide) and medium-sized (5–10m wide) hard-bottomed and soft-bottomed lowland rivers and small (1–3m wide) upper-catchment streams (Figs 2–5).

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

Figure 3. Soft-bottomed site on the Wairua River west of Whangarei.

Figure 4. Lowland site in Hikurangi north of Whangarei.

Figure 5. Upper-catchment site near Matauri Bay.

2.3 Sampling period

Samples were collected during February (10–20/02/12). All samples were collected during stable weather conditions and streams and rivers were at normal summer base-flow levels. However, rain events during December 2011 and January 2012 caused considerable flooding throughout Northland, particularly in the north and west (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. MCI and SQMCI data were transferred to the statistical package SigmaPlot 9.0 to produce LOWESS data points (tension of 0.4) for trend analysis following Stark & Maxted (2007b). The biotic indices below 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) suggest 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 hard-bottomed tolerance scores.

•The Semi-Quantitative Macroinvertebrate Community Index (SQMCI and SQMCI-sb)
These are similar to the MCI and MCI-sb, 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., $\sum (c_i \times a_i) / M$ (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 SQMCI hard-bottomed tolerance scores.