2 SURFACE WATER QUALITY

Overview

- The quality of freshwaters in Northland varies from pristine in indigenous forest catchments, to very poor in lowland agricultural areas. Guideline values for aquatic ecosystem health are not met in many areas, in particular the Mangahahuru, Mangere and Whakapara Rivers
- The Summer Recreational Bathing Survey has shown that many of the Region's lowland recreational areas can be unsuitable for bathing. Some sites, such as the Otiria River site, should not be used at all until work is carried out to mitigate the effects of upstream sewage disposal
- A study at Ruawai has shown excessively high levels of both *E. Coli* and Faecal Coliforms are present in the township's stormwater. Household sewage is the most likely source of this contamination
- Changes in macroinvertebrate communities over the last six years indicate that six of the 15 SoE sites have decreased in stream health, two have improved and seven have stayed relatively stable. Waiarohia sites have either deteriorated or remained reasonably stable
- Macroinvertebrate biotic indices for 2002/03 consistently showed sites at the Victoria, Waipapa and Waitangi Rivers had relatively good stream health, while sites on the Mangaharuru Stream, Wairua River, Kamo Tributary culvert and at the Provan Bridge on the Waiarohia Stream are of concern with respect to stream health

2002/2003 Annual Plan Performance Targets

To continue to develop and implement a prioritised State of the Environment monitoring programme based on the Regional Policy Statement and Regional Plans, by:

- **Operating a region-wide water quality network for the measurement, recording and reporting of river and lake quality trends**

2.1 Regional Water Quality Network

The Regional River Quality Monitoring Network (RWQMN), launched in 1996, was intended to gather data about Northland's river quality. From this research, environmental baselines can be established and water quality trends can be followed. By 2002-2003, the RWQMN encompassed fourteen sites managed by the NRC, plus another four sites monitored by NIWA as part of their National Quality Network. Samples from all eighteen sites are collected monthly, and analysed for a number of different physical and chemical properties. Most sample sites are at lowland rivers, although the Waipoua site is an exception, and is situated on a highland river. The locations of the RWQMN sites are presented in Figure 2-1.

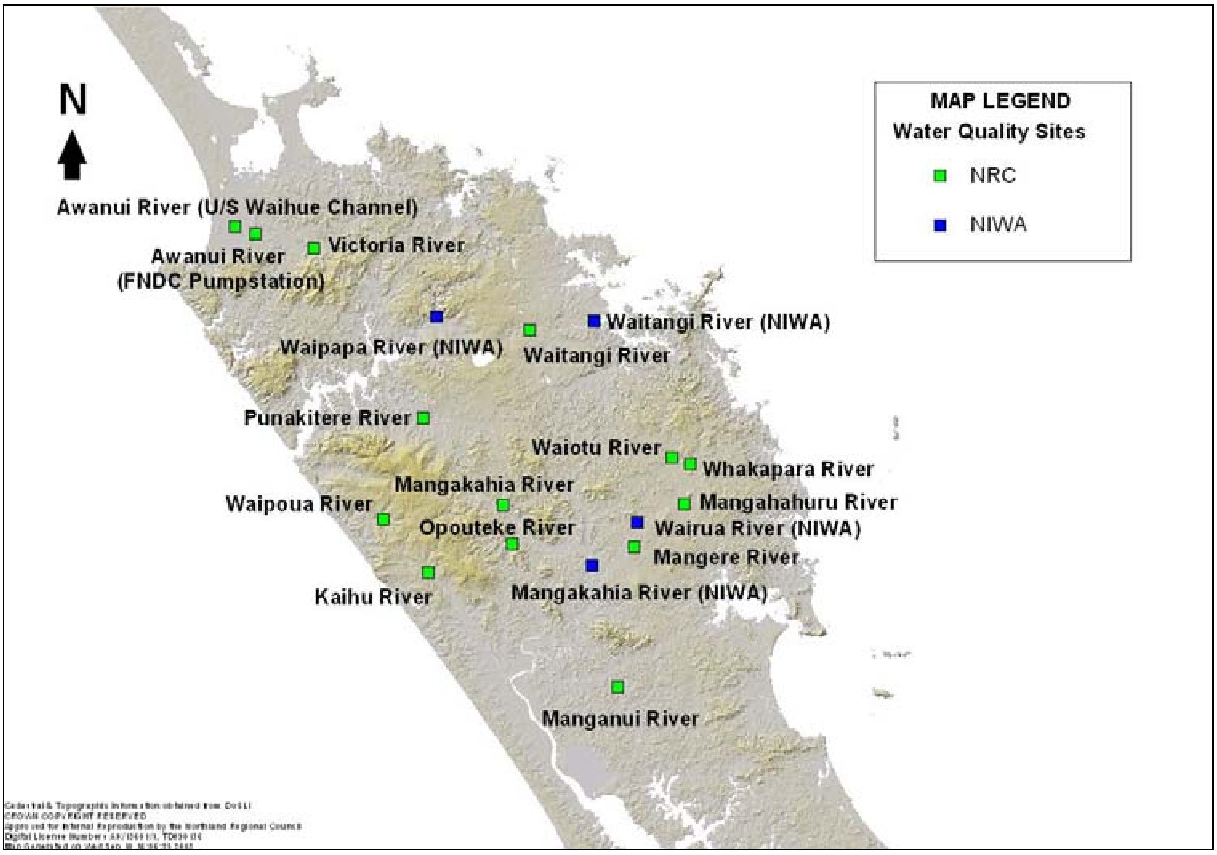


Figure 2-1 RWQMN Sites for 2002/2003

Following on from the **Annual Environmental Monitoring Report 2001-2002**, results for only four of the nineteen measured parameters are presented here: dissolved oxygen, turbidity, dissolved reactive phosphorous (DRP) and nitrite + nitrate nitrogen (NNN). These four characteristics are typically indicative of water quality in general.

2.1.1 Dissolved Oxygen

Dissolved oxygen is necessary for the survival of all aquatic animals, from snails and worms to eels and trout. Dissolved oxygen is produced by aquatic plants as a by-product of photosynthesis, and is transported from the atmosphere via diffusion and kinetic processes (waves, tumbling waters, etc…). Stagnant waters tend to have dissolved oxygen deficiencies. Another factor are microorganisms, which feed upon organic matter in the water column, and consuming dissolved oxygen in the process. Systems with high organic loading (such as streams affected by dairy farm effluent) are often under-saturated with respect to dissolved oxygen.

Dissolved oxygen levels fluctuate over a 24-hour cycle, with temperature and aquatic plant photosynthesis/respiration processes major influences. It is therefore important to sample at approximately the same time each sampling run, in order to compensate for diurnal variation. Dissolved oxygen saturation also varies between seasons. In winter, when rainfall is generally higher, dissolved oxygen saturation is noticeably higher compared to summer, during which time rainfall and thus flow-rates are lower.

Current ANZECC guidelines suggest that, although the amount of inherent variability makes % DO a poor indicator of ecosystem stress, healthy lowland waterways should range between 98 % and 105 % saturation. In highland waterways, dissolved oxygen saturation should lie between 99 % and 103 %.

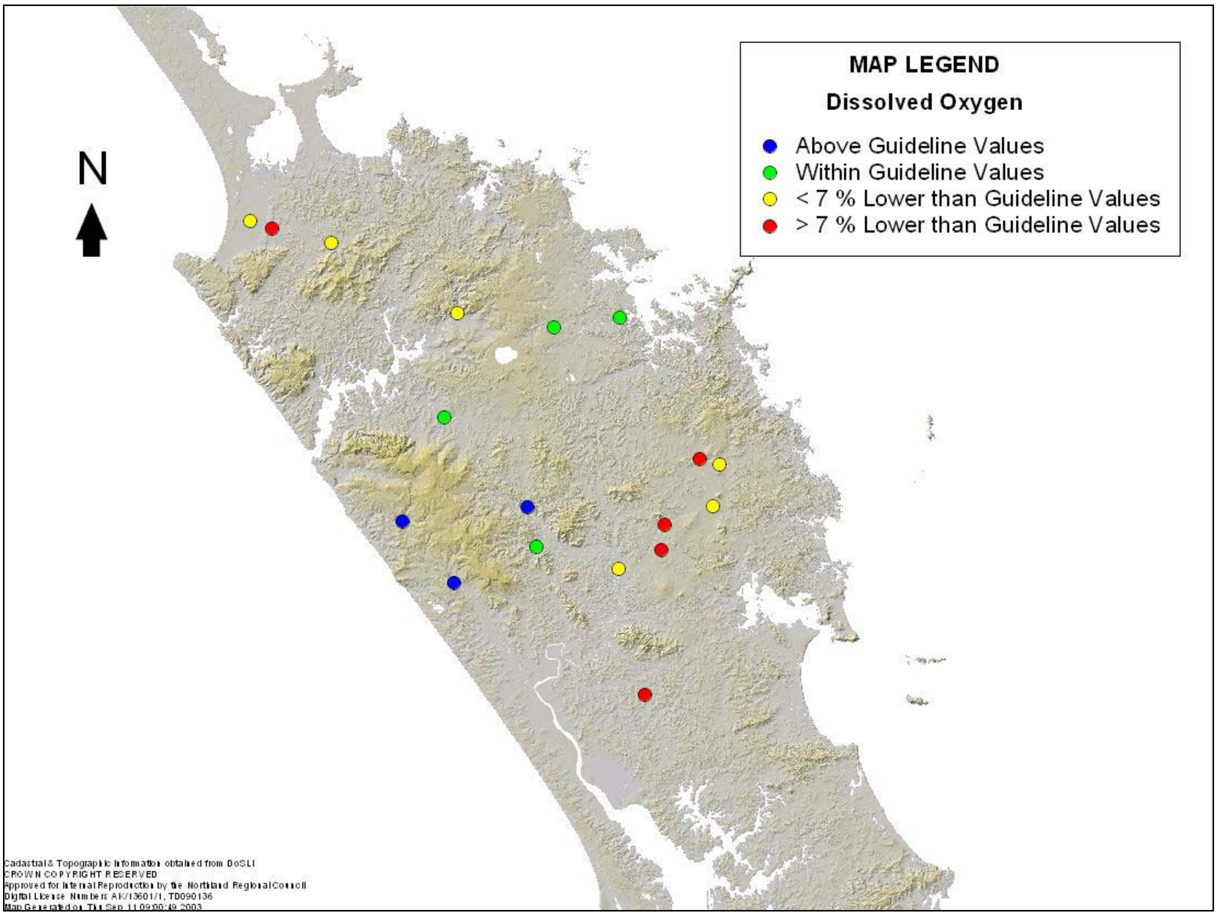


Figure 2-2 Mean dissolved oxygen at RWQMN sites throughout Northland for 2002/2003

Presented in Figure 2-2, it is evident that dissolved oxygen was typically higher in upper catchments (where the water tends to be more turbulent and have more energy), than in the lower reaches, where dissolved oxygen saturation can be quite low. Oxygen saturation was lowest in the Wairua catchment, which is heavily impacted by dairy and pastoral agriculture. Likewise, the upper Awanui and Manganui sites are also situated in intensely farmed areas.

2.1.2 Turbidity

Turbidity is a measurement of how much light is scattered by particles in water. In waterways with high turbidity, sunlight is absorbed, reflected and refracted to an extent that available sunlight becomes limited or (in extreme cases) non-existent. Without sunlight, aquatic plants (like all plants) cannot survive. ANZECC guidelines suggest that turbidity in lowland rivers greater than 5.6 NTU (Nephelometric Turbidity Units) is an indication of ecosystem stress. For highland rivers, such as the Waipoua, the threshold is 4.1 NTU.

Most rivers in Northland have sandy or silty bottoms, and therefore have naturally high turbidity, as unconsolidated sediment is stirred up and transported into the water column. Inorganic contaminants in run-off and erosion can also affect turbidity.

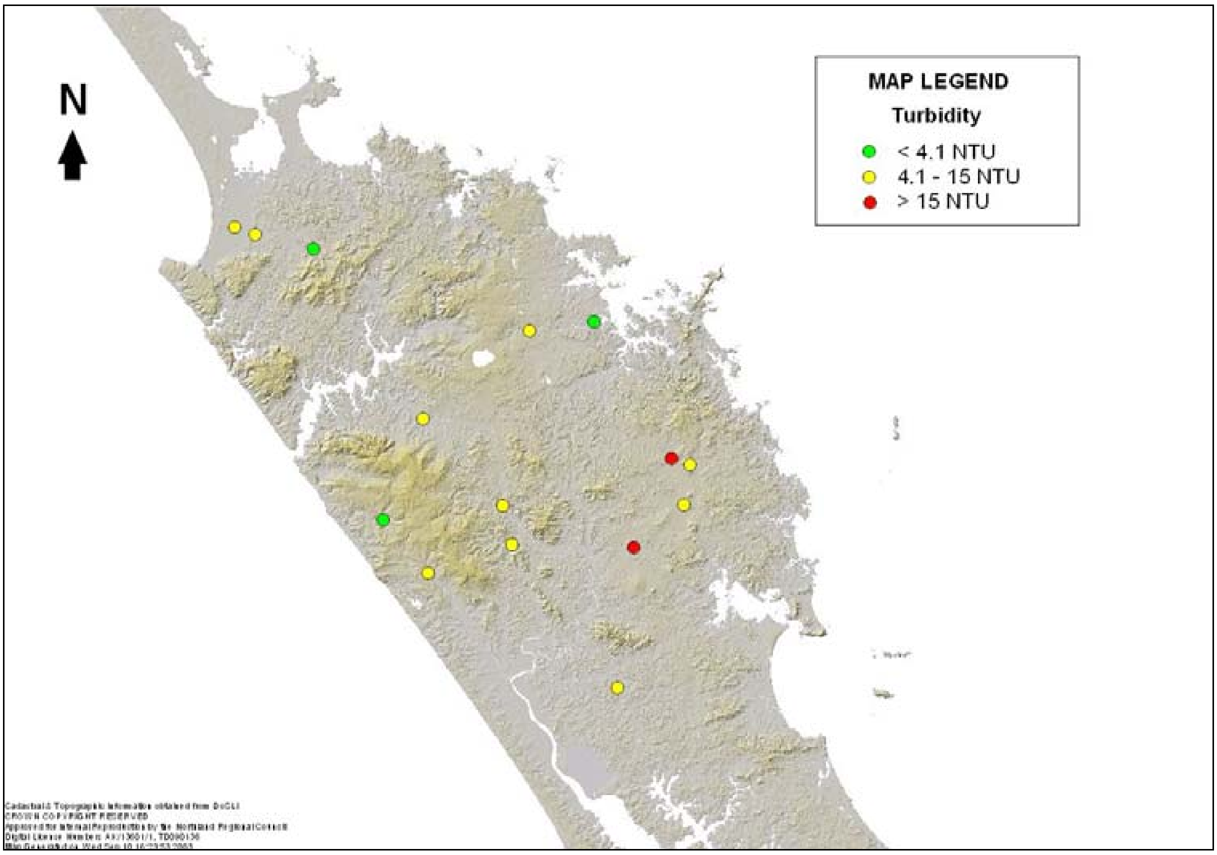


Figure 2-3 Mean turbidity results from the 2002/2003 monitoring programme. Three sites, the NIWA sites at the Mangakahia, Waipapa and Wairua rivers had insufficient data and were excluded from analysis

As shown in Figure 2-3, and as previously indicated, most rivers sampled as part of the RWQMN have high turbidity. Sites with low turbidity (the Victoria, Waipoua and Waitangi rivers) are in native forest, and much less affected by either run-off or erosion. Rivers with the highest turbidity (Waiotu River, the Mangakahia River, and the Mangahahuru River) are all situated in agricultural areas.

2.1.3 Nutrients (Dissolved Reactive Phosphorous (DRP) and Nitrite+Nitrate Nitrogen (NNN))

Phosphorous and nitrogen are essential elements for plant growth. Phosphorous is used in the transfer and storage of energy, while nitrogen is an ingredient in a wide range of proteins, coenzymes and nucleic acids. In some ecosystems, phosphorous and nitrogen are bio-limited, that is plant growth is restricted by the amount of phosphorous and/or nitrogen available. In other systems though, it is not a lack of either element that is an issue, but an excess.

In aquatic systems with a surplus of either element, it is possible for algal blooms to occur. Given the right conditions, algal growth (no longer limited by nutrients) increases exponentially, with growth far outstripping predation by zooplankton and macro-invertebrates. Large growths can block sunlight, and cause eutrophic processes (such as a reduction of dissolved oxygen in the water column and the death of benthic (bottom-dwelling) life). At present, lowland rivers with more than 0.444 g m^{-3} dissolved inorganic nitrogen or 0.01 g m^{-3} dissolved reactive phosphorous are considered to have exceeded current guidelines. For highland rivers, the limits are lower: 0.167 g m^{-3} NNN and 0.09 g m^{-3} DRP.

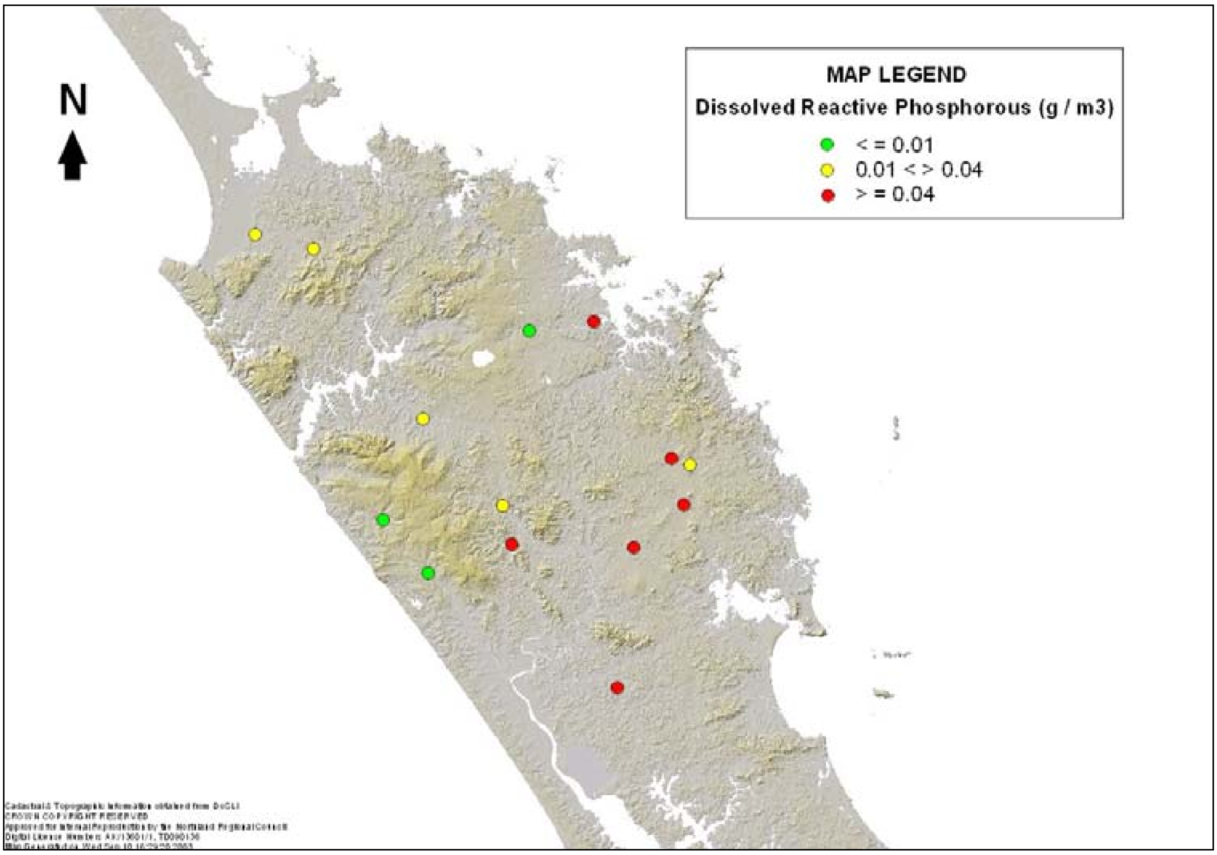


Figure 2-4 Mean DRP at RWQMN sites during 2002/2003

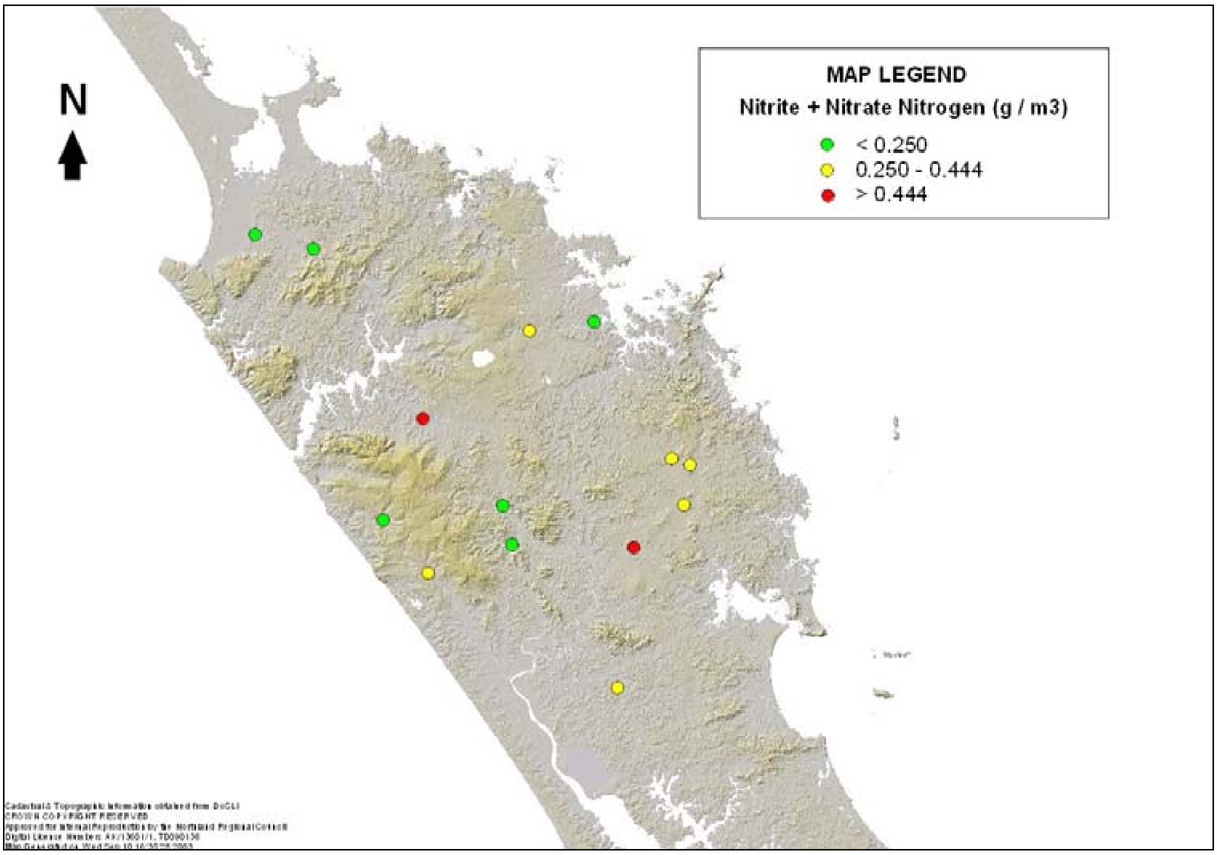


Figure 2-5 Mean NNN results from the 2002/2003 monitoring year

The Dissolve Reactive Phosphorous profile (Figure 2-4) bears some resemblance to the turbidity profile previously discussed (Figure 2-3). DRP levels were lowest in native forest localities, and highest in agricultural catchments such as Mangere River or Mangahahuru Stream. With a large number of sites exceeding ANZECC guidelines, the lower catchments could be vulnerable to algal blooms in the future, as phosphorous (whose scarcity usually limits algal growth) is in present in excess.

Seasonal variation of DRP was apparent at some but not all sites. Where seasonal variation did occur, DRP tended to be higher in summer and lower in winter.

NNN levels (Figure 2-5) were within ANZECC guidelines at most sites throughout the region. The only areas at which average NNN levels exceeded the guidelines were at Mangere and Punakitere. The Mangere River is greatly impacted from the cumulative effects of dairying upon upstream tributaries, and it may be concluded that, overall, the Mangere River is in very poor health. The Punakitere River is currently the only RWQMN site downstream from an urban area (Kaikohe township), and it may be that elevated NNN levels there are due to urban processes.

NNN values were subject to seasonal variation. NNN levels appear to be influenced by rainfall and therefore run-off, as NNN was typically higher during winter than in summer.

No data for either dissolved reactive phosphorous or Nitrite + Nitrate Nitrogen was available for the Awanui River upstream of the Waihue Channel, nor from the NIWA sites at the Mangakahia, Waipapa or Wairua rivers.

2.1.4 Future Changes

In the **Water Quality Monitoring Regional Monitoring Strategy 2003**, a number of recommendations were made regarding the RWQMN. These included:

- That future expansion of the RWQMN is necessary, and that sites are required in higher order streams, in both hard and soft sedimentary types, from wetland and spring sources, and in both exotic and native forested areas
- That future expansion of the RWQMN should consider the option of rolling sites to help determine a more comprehensive understanding of water quality in the region

The Mangere (Poor health) and Waipoua (Good health) Rivers

2.2 Recreational Bathing

The bacteria *Escherichia coli* (*E. coli*) is a good indicator of human and animal waste contamination in freshwaters. The Regional Council conducts a survey of certain freshwater bathing sites throughout the region during summer. The Council uses this information to assess whether the water at the studied sites is suitable for contact recreation.

Over the coarse of the summer of 2002/2003, fourteen sites were surveyed from Lake Ngatu just north of Kaitaia, down to Lake Taharoa south of Dargaville. Water was graded based on how many individual samples exceeded alert (260 *E. coli* per 100 mL) and/or action (550 *E. coli* per 100 mL) values as prescribed by the Ministry for the Environment. At "Good" sites, all samples were below alert values, while at "Very Poor" sites the majority of samples exceeded action values. This information shows that over a third of the sites throughout the region are of poor or very poor quality. Major pressures upon the surveyed sites include increased run-off after major rain events, wastewater discharges and septic tank seepage. Sites are currently monitored seven times per summer, significantly fewer than the minimum twenty recordings required for sites to be formally graded under Ministry for the Environment guidelines.

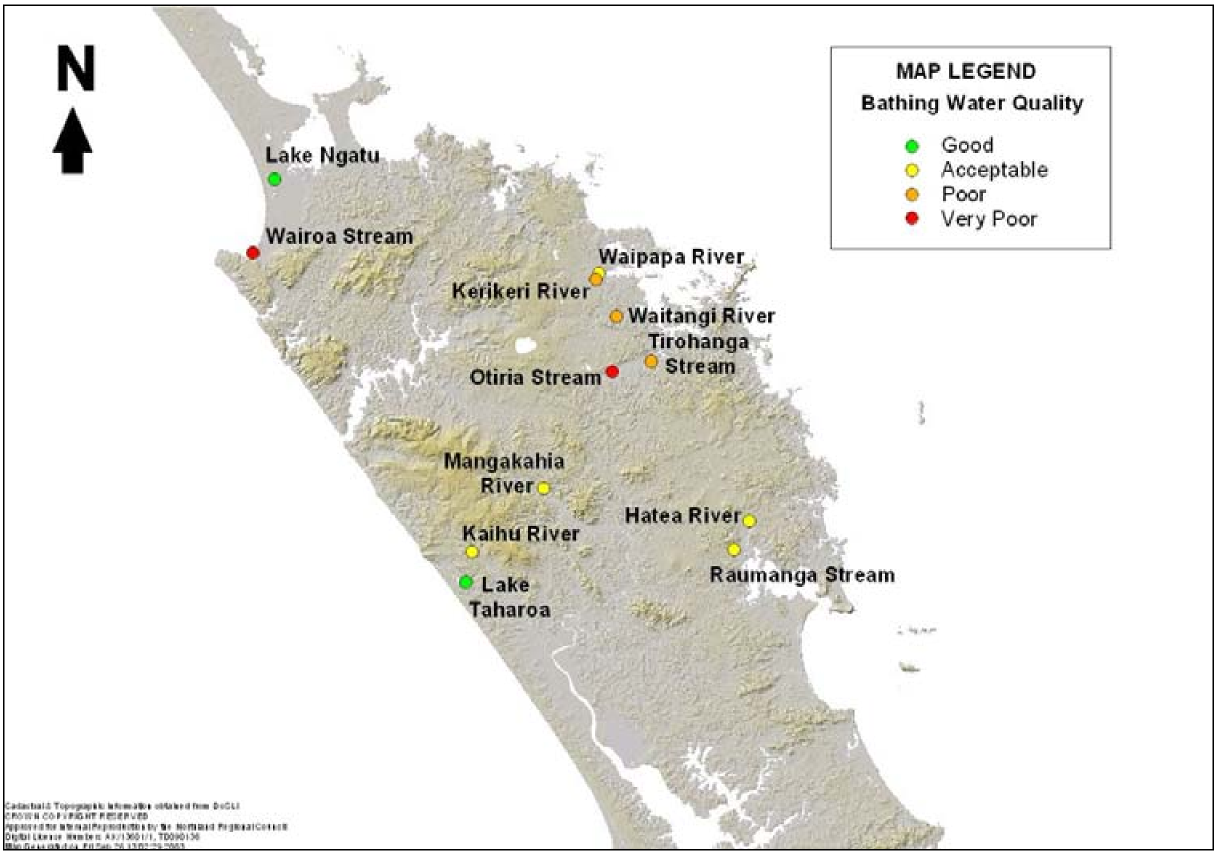


Figure 2-6 Sites sampled during the 2002/2003 summer survey (There are two sample sites at each lake). E. coli data is also collected monthly from the RWQMN sites presented in Figure 2-1.

2.2.1 Results

Of the 14 summer survey sites, only five achieved 100 % compliance with the Ministry for the Environment's Revised Freshwater Guidelines (<550 *E. coli* per 100 mL of water). Of the five, four were situated upon pristine lake sites (Lakes Ngatu, and Taharoa), while the Waipapa Stream was the only river that did not exceed the threshold limits. Of the remaining 9 sites, compliance ranged from 92 % (Tirohanga Stream) down to 46 % (Otiria Stream). As such, these nine sites should be considered potentially unsafe for contact recreation, especially the Otiria Stream site, at which recreational bathing is discouraged until water quality upstream significantly improves.

As seen in Table 2-1, compliance was not necessarily comparable to median *E. coli* counts. At the Kaihu site for example, median *E. coli* was only 30 per 100 mL, well below even the alert threshold of 260 per 100 ml, yet compliance was only achieved 57 %. This was largely because of significant run-off during January 2003. In contrast, median E. coli level at Tirohanga was almost 300 per 100 mL, but the site achieved compliance 92 % of the time.

Table 2-1 Results of the 2002/2003 Summer Survey

Site	Median E. coli per 100 ml	Compliance
Lake Taharoa at Promenade Point	1	100 %
Lake Taharoa at Pump House	5	100 %
Lake Ngatu at Launch Site	5	100 %
Lake Ngatu at South End	11	100 %
Waipapa Stream at Landing	109	100 %
Tirohanga Stream	298	92 %
Hatea River above Whangarei Falls	331	78 %
Waitangi River at Lily Pond Reserve	134	71 %
Mangakahia River at Twin Bridges	221	71 %
Raumanga Stream below Falls	262	71 %
Kerikeri River at Stone Store	278	67 %
Wairoa Stream at Ahipara	371	60 %
Kaihu River at Motor Camp	30	57 %
Otiria Stream at Falls	579	46 %

2.2.2 Future Changes

It has been recommended that from 2003/2004 an Omamari Beach Stream site be included in the survey. It has also been suggested that frequency of sampling be increased from seven to ten times over the course of the summer months. In the **Freshwater Quality Monitoring Regional Monitoring Strategy 2003**, it was noted that further implementation of microbiological guidelines should include the integration of other governing bodies, such as Northland Health and the Ministry for the Environment.

2.3 Case Study: Ruawai Drains

The council is constantly involved in smaller studies, not necessarily detailed or sustained enough to be considered **State of the Environment** monitoring, but nonetheless providing data that provides a greater understand of our environment. These investigations are typically more concerned with anthropogenic rather than ambient environmental issues, often developing from public concerns. A study of stormwater at Ruawai is a classic example of such a project:

Ruawai

Samples taken from drains within the Ruawai settlement during 2002 and 2003 indicated that stormwater drains are heavily contaminated with sewage effluent, at levels that far exceed limits contained in the **Revised Proposed Regional Water and Soil Plan for Northland**.

Eight sites throughout the township were sampled for *E. coli* and faecal coliforms (Figure 2-7). Results showed that, on average, the median level of *E. coli* in stormwater drains was 10869 per 100 mL of water. This exceeds the water quality guidelines for contact recreational use by 86 times, and is 18 times higher than recommended irrigation/stock drinking limits. Sites at each end of the township contained the lowest levels of contaminants. Median faecal coliform counts averaged about 8656 per 100 mL.

The most likely cause of the contamination is discharges from household septic tank systems within the township. An extremely high water table over winter months also contributed, causing increased leaching of contaminants, and reducing the effectiveness of the treatment systems.

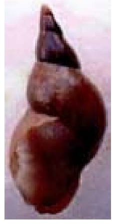
Figure 2-7 Ruawai Drains sampling sites

2.4 Macroinvertebrate Monitoring

Macroinvertebrates are widely used as indicators of water quality in New Zealand. The advantage of using macroinvertebrates to assess water quality is their ability to portray changes in environmental conditions over time, and that different macroinvertebrates have a range of responses to differences in water quality. Examples of species commonly found in polluted rivers and species that are sensitive to pollution are shown in Figures 2-8 and 2-9 respectively.

Freshwater worm – Oligochaeta (1)

Midge Larvae – Diptera (2)

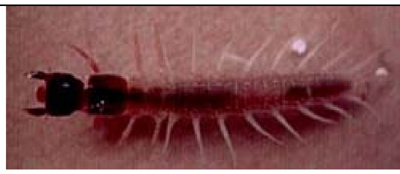


Snail – Mollusca (4)

Figure 2-8 Examples of macroinvertebrates tolerant of organic pollution, with MCI scores shown in parentheses

Mayfly – Ephemeroptera (9)

Cased caddisfly – Trichoptera. (9)



Dobsonfly – Megaloptera (7)

Figure 2-9 Examples of macroinvertebrates sensitive to organic enrichment, with MCI scores shown in parentheses

Several biotic indices were calculated to predict stream health, using the invertebrate communities present in selected streams. In this report the following biotic indices are used:

- **Species Richness** – the number of taxa collected in a sample is a representation of the biodiversity of macroinvertebrates at the site. Species richness in this report is to the taxonomic level of the Macroinvertebrate Community Index but also includes species that have not been assigned a MCI score. A high species richness can be associated with both clean, unpolluted streams and streams impacted by nutrient enrichment.
- **Macroinvertebrate community Index** – The MCI is an index based on the presence of macroinvertebrate taxa with preassigned scores based on their tolerance to organic pollution, where 1 = highly tolerant and 10 = highly sensitive. Scores greater than 120 are considered 'pristine', between 80 and 120 'moderately impacted' and scores less than 80 are 'severely polluted'.
- **Semi Quantitative MCI** – the SQMCI is similar to the MCI but also takes into account the coded abundance of each species. Where the MCI uses only presence-absence data, the SQMCI accounts for whether a species is rare or abundant in the sample.

- **Percentage of EPT taxa** – the proportion of taxa collected in a sample representative of 3 groups: Emphemeroptera, Plecoptera and Trichoptera (mayflies, stoneflies and caddisflies), which are generally sensitive to pollution. The caddisflies *Oyxethira* and *Paraoxyethira* were excluded from % EPT in this report, as they are relatively tolerant of pollution.

When analysing the change in macroinvertebrates over the last 6 years, variations of the above biotic indices have had to be used, due to the differences in data recording. Both the **Open Ended MCI** (OEMCI) and **Quantitative MCI** (QMCI) are similar to the SQMCI, except that OEMCI uses a different coding system and QMCI uses actual abundances for each species rather than coded abundances. The **percentage of EPT individuals** is the same as the percentage of EPT taxa except it takes into account the proportion of individuals that are collected.

OEMCI was used from November 1997 to March 1999, before it was replaced by SQMCI, which can be calculated up to March 2003. The percentage of EPT individuals and QMCI can only be calculated from November 1999 to March 2002. Species richness, MCI and percentage of EPT taxa were used in all 6 years.

2.4.1 Waiarohia Stream

Species richness in the Waiarohia Stream varies from 5 to 21 (Figure 2-10). Species Richness, MCI, SQMCI and % EPT taxa are all lower in March, rather than November. This could be due to a number of reasons such as the in-stream disturbance caused by high flows in late February/early March or an indication of a loss in water quality.

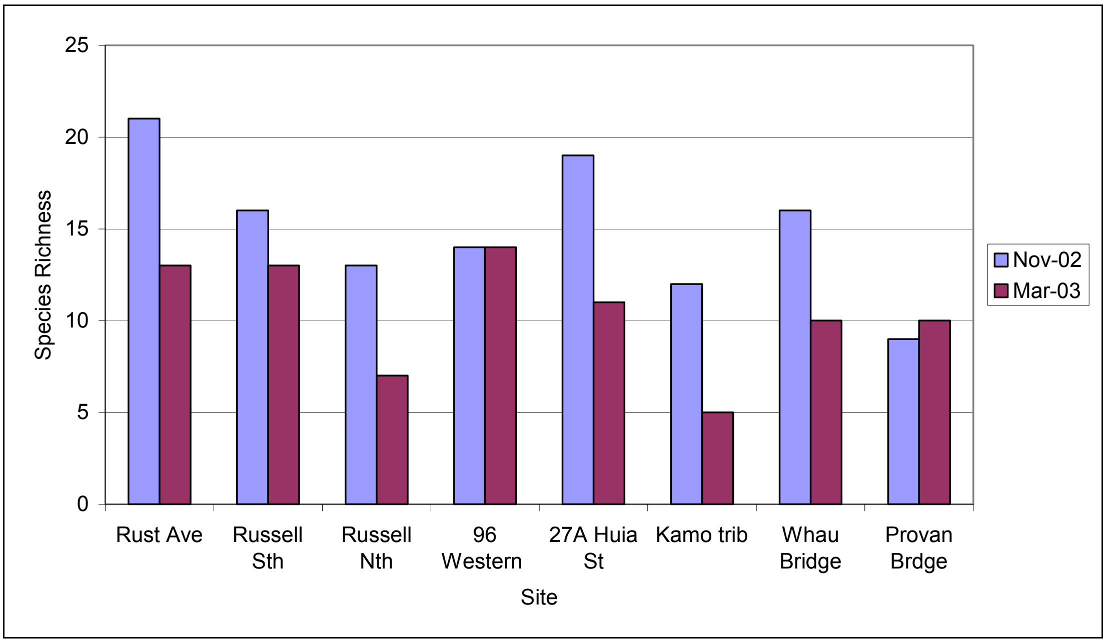


Figure 2-10 Invertebrate species richness at the 8 Waiarohia Stream sites in November 2002 and march 2003.

In general, the MCI scores indicate that Waiarohia Stream is moderately impacted by organic pollution (Figure 2-11). However, both the Kamo Tributary Culvert and Provan Bridge have MCI scores of less than 80 in both November and March indicating severe pollution. The culvert contains mainly storm water run-off from urban and minor industrial areas of Kamo and therefore the source of pollution is probably inorganic, while the Provan Bridge site is situated in pastoral farming, so organic pollution is likely.

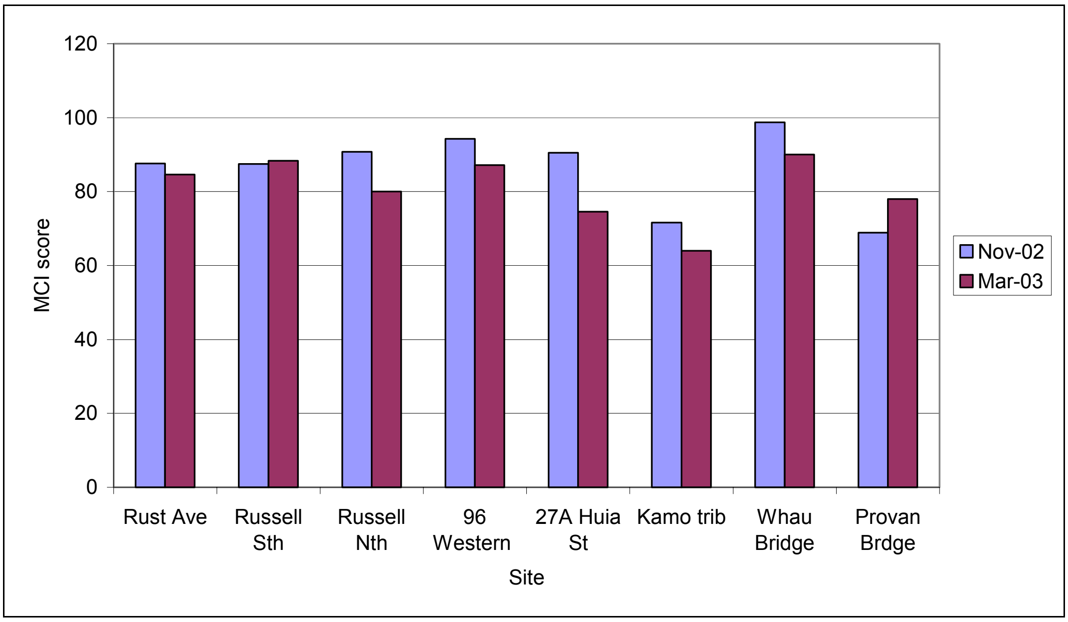


Figure 2-11 Macroinvertebrate Community Index scores for the 8 Waiarohia sites in November 2002 and March 2003.

SQMCI (Figure 2-12) takes into account the relative abundances of each taxa and therefore shows slightly different results to the MCI. The SQMCI scores show that the Kamo Tributary Culvert is the most impacted, followed by the Provan Bridge, Rust Ave Bridge and Russell Road Bridge South. The latter two sites have higher abundances of some of the more pollution tolerant, lower scoring taxa. For example, *Potamopyrgus sp*. (snail), with a MCI score of 4, is common at Rust Ave and Russell Road South, but are rare at the Kamo Tributary. These differences between sites could be due to the influence of habitat quality rather than water quality. For example, the lower sites (e.g. Rust Ave, Russell Road South) are more open and have less shading and therefore have much greater amounts of aquatic weed growth, providing ideal microhabitats for grazers such as snails.

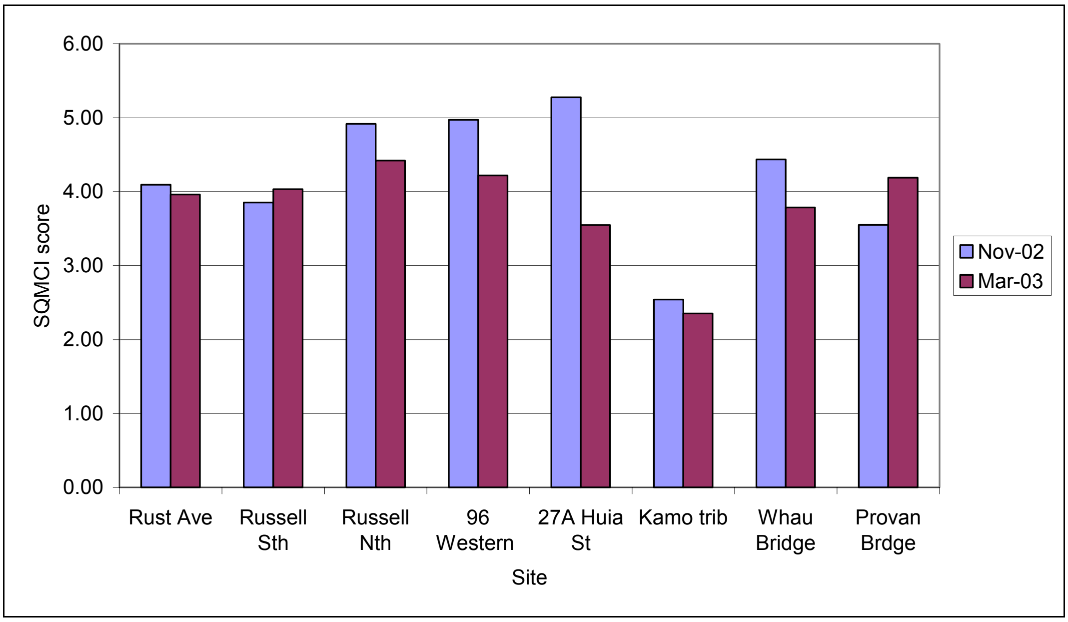


Figure 2-12 Semi Quantitative MCI scores for the 8 Waiarohia sites in 2002/03

The percentage of EPT taxa at the 8 Waiarohia sites supports the results shown by the other indices above, with the Kamo tributary culvert having the lowest percentage of pollution sensitive EPT taxa (Figure 2-13). None of the sites had a percentage greater than 50%. This, along with all MCI scores less than 100 and all but one SQMCI less than 5.0, suggests that the Waiarohia Stream has moderate overall stream health when compared to the state of the other monitored streams and rivers in Northland.

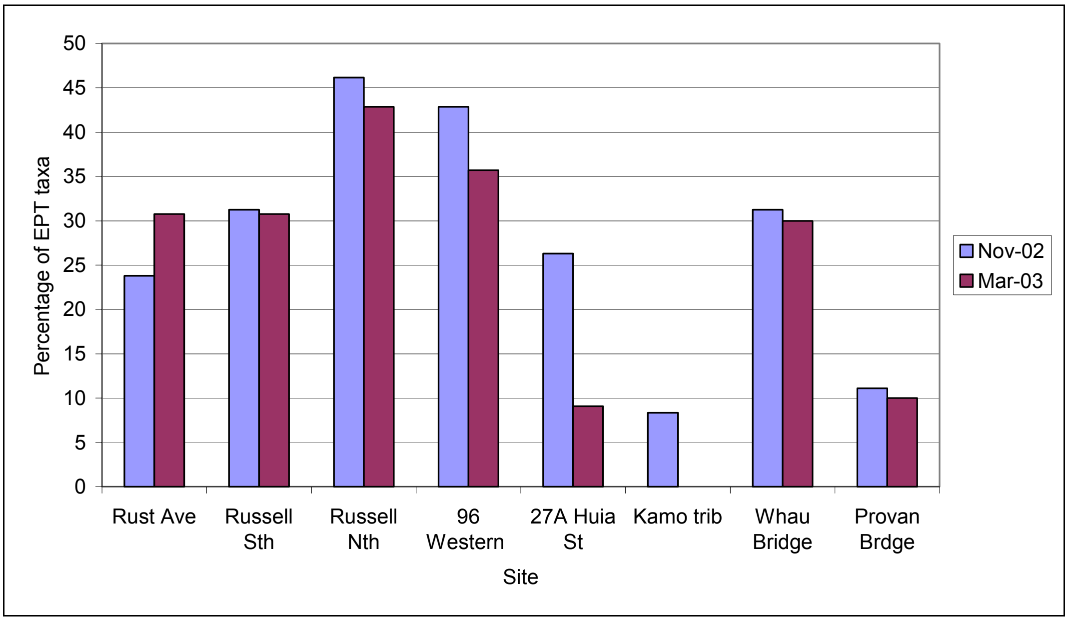


Figure 2-13 Percentage of EPT taxa at the 8 Waiarohia sites in 2002/03.

2.4.2 State of Environment and Regional Water Quality Network Sites

As for Waiarohia, species richness at SoE sites was highest in November, and varied greatly between the 15 sites (Figure 2-14). Victoria River at Thompsons Bridge (Awanui catchment) and Mangere Stream at Knights Bridge and Waipapa River in Puketi Forest had the highest invertebrate species richness. These sites are all high in their catchment with mainly indigenous forest and minimal effects from farming.

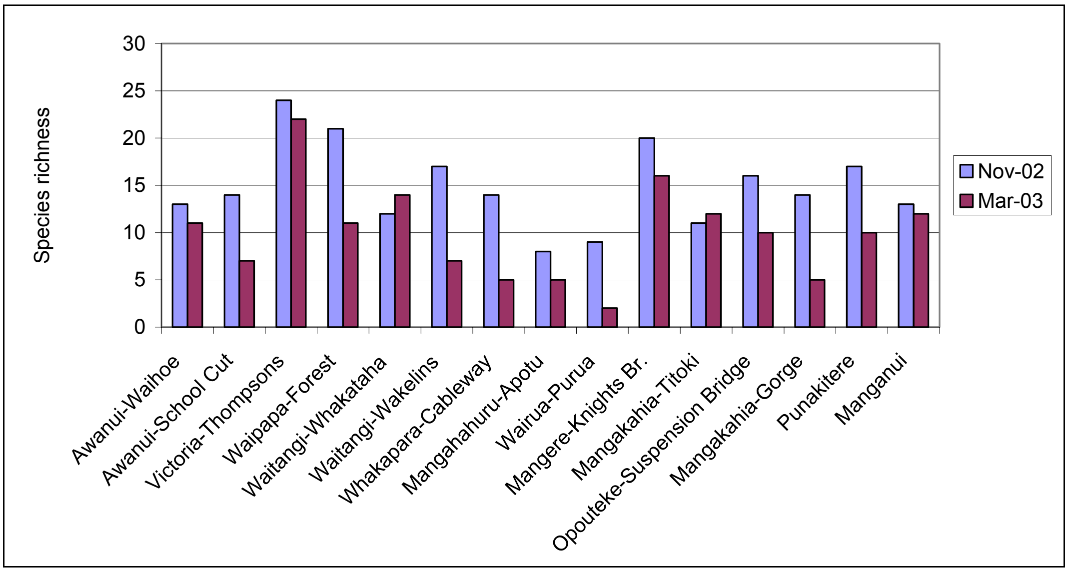


Figure 2-14 Invertebrate species richness at the 15 State of the Environment sites throughout Northland in November 2002 and March 2003.

As shown on Figure 2-15, MCI scores at the 15 SoE sites were generally better than the Waiarohia Stream sites. Victoria River at Thompsons Bridge, Waipapa at Forest Ranger and Waitangi River at Whakataha had scores of 120 or greater, indicative of 'pristine' stream health. Awanui at Waihoe, Waitangi River at Wakelins, Whakapara at Cableway, Mangahahuru at Apotu Bridge, Wairua at Purua and Manganui all have at least one MCI score indicative of severe organic pollution.

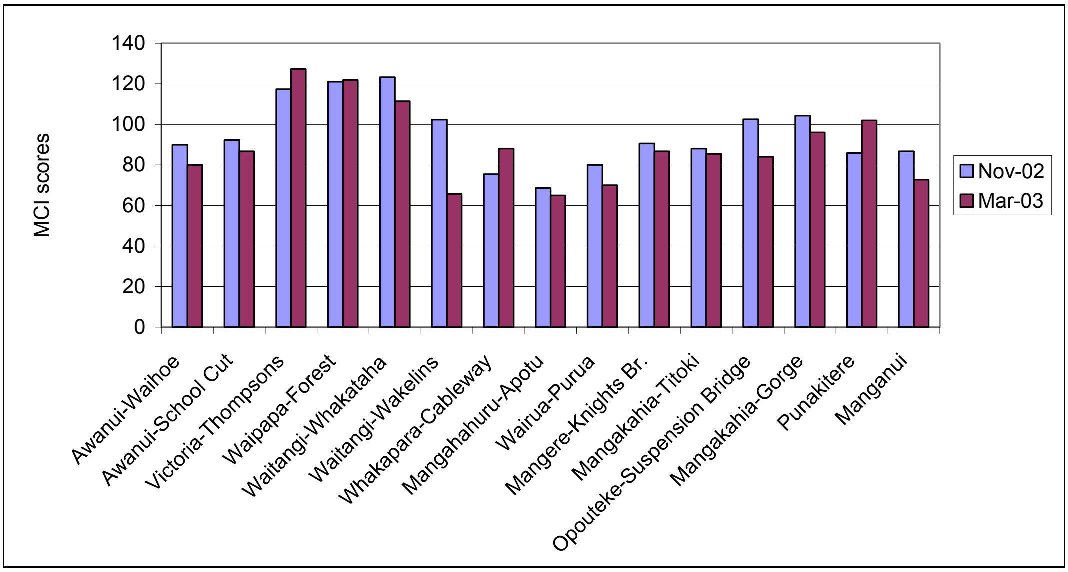


Figure 2-15 Macroinvertebrate Community Index scores at the 15 State of the Environment sites throughout Northland in November 2002 and March 2003.

The Awanui, Victoria, Waipapa, Waitangi (at both Wakelins and Whakataha) and Punakitere Rivers all have SQMCI scores indicative of slight organic pollution (Figure 2-16). The other sites have SQMCI scores less than 5, indicative of moderate to severe organic enrichment.

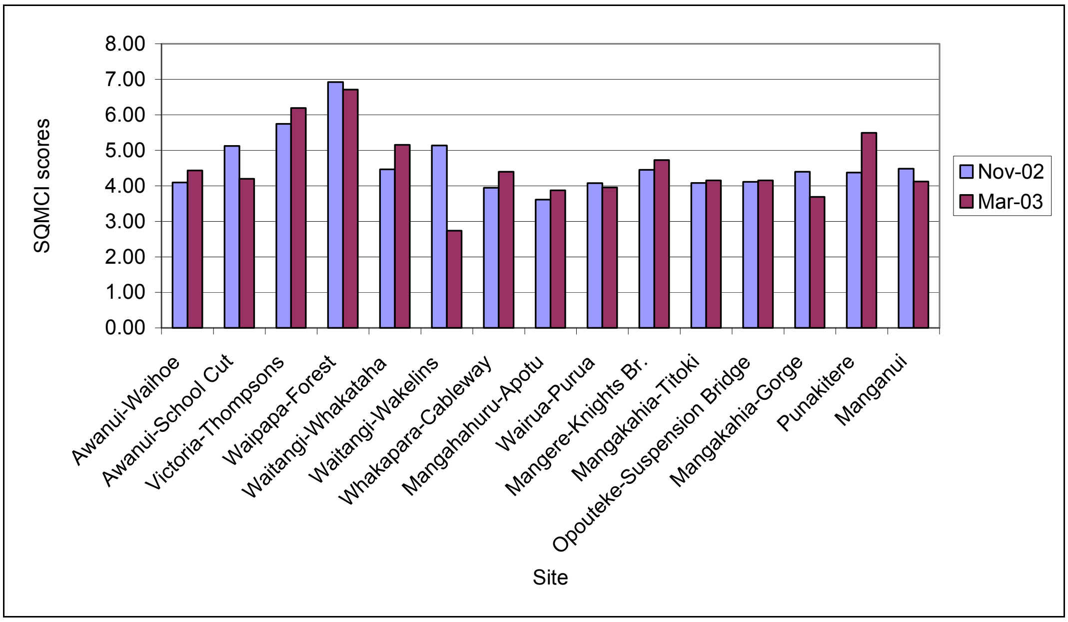


Figure 2-16 Semi Quantitative MCI scores at the 15 State of the Environment sites throughout Northland in 2002/03.

In at least one sample from each of the Victoria River, Waipapa River and the Waitangi River (at both Whakataha and Wakelins) sites, over 50% of the species belong to the more sensitive orders of Ephemeroptera, Plecoptera and Trichoptera (EPT), as evident in Figure 2-17. There was no EPT species found in Mangaharuru Stream, while the Wairua River at Purua, the Mangere Stream at Knights Bridge and the Manganui River all had a very low representation of EPT taxa.

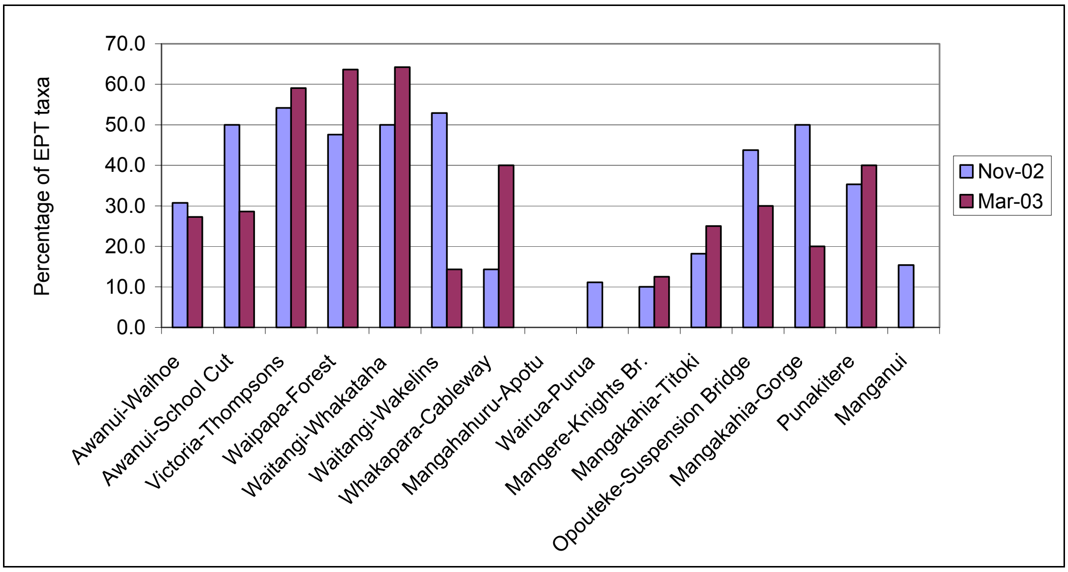


Figure 2-17 Percentage of EPT taxa at the 15 State of the Environment sites throughout Northland in 2002/03.

2.4.3 Changes in the State of Northland Rivers and streams

Overall, of the eight Waiarohia Stream sites monitored in 2002-2003, one (Whau Valley Bridge) has significantly deteriorated, 3 have had a moderate decrease in stream health and 4 have remained reasonably stable. Although the Whau Valley Bridge site has clearly shown the worse decline in the health of its macroinvertebrate community, it still is one of the healthier sites on the Waiarohia Stream.

The change in macroinvertebrate communities over the last six years indicates that six of the 15 SoE sites have decreased in stream health, two have improved and the other seven have stayed relatively stable. These trends are displayed in Table 2-2.

Table 2-2 Change in stream health indicated by Macroinvertebrate indices at the 8 Waiarohia Sites and 15 SoE sites from November 1997 to March 2003. ↑↑ = Large or significant increase, ↑ = Slight to moderate increase, ↓ = slight to moderate decrease, ↓↓ = large or significant decrease, - = stable or fluctuating. Note: Punakitere and Manganui have only been sampled for 2 years.

Site	Species richness	MCI	OEMCI	QMCI	SQMCI	%EPT taxa	%EPT individuals	OVERALL
Waiarohia – Rust Ave	-	-	-	-	↓	-	-	-
Russell Rd Sth	-	-	↓	-	-	-	-	-
Russell Rd Nth	↓↓	↓	↓↓	↑	-	-	-	↓
96 Western Hills	↓	↓	↓↓	-	-	↓↓	↑↑	↓
27A Huia St	↓↓	↓	-	-	-	↓	-	↓
Kamo Trib. Culvert	↓	-	↑	-	↓	-	-	-
Whau Valley Bdge	↓↓	↓↓	↓↓	↓↓	↓↓	↓	↓	↓↓
Provan Brdge	↓	-	↓↓	-	↑	-	-	-
Awanui – Waihoe	-	-	-	-	↑	-	-	-
Awanui – School Cut	-	↑	-	-	-	↑	↑↑	↑
Awanui – Thompsons	-	-	↓	-	-	-	↑	-
Waipapa - Forest	↓↓	-	↓↓	↓↓	↓↓	↑	-	↓
Waitangi - Whakataha	↓	-	↓	↑↑	-	↑	↑↑	-
Waitangi - Wakelins	↓↓	-	↓↓	-	-	↓	-	↓
Whakapara - cableway	↓↓	-	↓↓	↑	-	-	-	↓
Mangaharuru - Apotu	↓	-	-	-	-	-	-	-
Wairua – Purua	-	-	-	-	-	↓	-	-
Mangere – Knights Rd	-	-	-	↑	↑	↓	↑↑	↑
Mangakahia - Titoki	-	↓	↓↓	-	-	↓	-	↓
Oputeke – Suspension Bridge	↓	-	↓↓	-	-	↓	-	↓
Mangakahia - Gorge	↓↓	↑	↓↓	↓↓	↓	-	-	↓
Punakitere	↓	-	-	↓	-	-	↑	-
Manganui	-	-	-	↑	-	-	-	-

2.4.4 Future Developments

The following changes to the macroinvertebrate monitoring programme were identified in the **Freshwater Quality Monitoring Regional Monitoring Strategy 2003** to occur in the forthcoming year of 2003-2004:

- Reduce the number of sites on the Waiarohia Stream from 8 to 3 and add Kaihu, Waipoua and Waiotu RWQMN sites.
- Reduce monitoring to once a year in February, instead of twice a year as done currently.
- NRC staff to collect samples that will be sorted and analysed by contractor, before NRC staff report on data. In the past all macroinvertebrate monitoring has been contracted out from start to finish.