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REMS report for 2001

Final

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Executive Summary

Information collected from the Regional Ecological Monitoring of Streams (REMS) programme in the year 2000 was analysed using a multimetric approach. Streams were classified as Excellent, Satisfactory and Unsatisfactory using a modified United States Environmental Protection Agency (USEPA) protocol. Data collected from three consecutive years starting in 1998 were also analysed using four metrics to examine trends in the invertebrate communities over time. The data from the three years was also examined for significant differences between pastoral and native streams.

The majority of the streams in the Waikato Region were classified as unsatisfactory. These streams tended to be in catchments that were developed for either intensive or extensive pastoral farming. Streams that were classified as Satisfactory or Excellent were generally located in the undeveloped catchments in higher elevation areas e.g., Coromandel Ranges.

The Macroinvertebrate Community Index, Species Number, Ephemeroptera Plecoptera and Trichoptera (EPT) and Percent Ephemeroptera indices all showed consistent results over the three years with no significant differences observed. There were however, significantly higher scores for the MCI and EPT scores in the native streams over the three years. The results from 1998 showed a larger range in values for both of these indices and overlapped with the scores from the native streams. The implication from these results is that improved management of land and riparian margins is likely to significantly improve the quality of our aquatic ecosystems in the Waikato Region. It is also prudent to note that some streams in the Region will be more easily improved than others. More study will be required in order to prioritise the catchments in the Waikato Region for improvement and increase our knowledge of the riparian management options for differing catchments.

1 Introduction

Aquatic invertebrates are commonly found in river systems and are recognised as indicators of water quality (Stark, 1993). Habitat also plays an important part in the structuring and functioning of aquatic macroinvertebrates (Petersen, 1992). Large scale conversion of land for agriculture and horticulture has a significant effect on the assemblage of stream invertebrates found in streams and rivers (Collier, 1995, Harding & Winterbourn, 1995). Aquatic invertebrates are therefore important indicators of stream health and condition and allow us to measure the impact of different activities on the land.

The Regional Ecological Monitoring of Streams (REMS) programme was created in 1995. Since 1996 annually, staff have collected information from a large number of streams in the Waikato Region during the summer period. Initially new sites were added every year to get maximum coverage in the Region, in 1999 the sites were reduced to 125 representative sites on the basis of their invertebrate composition and geographical spread. There were some errors in the sites sampled in one year, reducing the dataset – therefore there is only two years of continuous data for the 123 sites (two sites were removed because of accessibility problems) collected to date.

REMS collects information from wadable (able to be waded across) streams – both cobbly bottomed and soft bottomed streams in the Waikato Region. The substrate type is an important issue for the streams in the Region and appears to be important in the structuring of the invertebrate communities (Quinn & Hickey, 1990). The soft bottomed streams tend to have fewer and more pollution tolerant taxa present. More work is required in these soft bottomed streams to assess better techniques for assessing the 'health' of these streams. To date information in these streams has been assessed using a variety of metrics derived from stony bottomed streams e.g., Macroinvertebrate Community Index (Stark, 1985). A multimetric system of analysing the data has also been adopted using a modified USEPA protocol (Barbour *et al.*, 1999)

The data from the REMS programme has been primarily used for State of the Environment monitoring for the Waikato Region, and formed the basis for information presented in the State of the Environment Report (Environment Waikato, 1998). This information has also been used by various other groups e.g., Whaingaroa catchment report, consultants examining stream health. Future work in Local Area Management Strategies will also benefit from information collected by the REMS programme.

Biological information is becoming more widely used in environmental assessment and will increasingly form the basis for decision making in Regional Council and other agencies. Integrated monitoring of the environment with other sources of information e.g., fisheries will provide a more holistic basis for assessing the health and needs of aquatic ecosystems in the future.

The overall aim of this report is to:

1. Present the results of the multimetric index for the 2000 data.
2. Provide some analyses of three years worth of data to examine overall trends in the data for 43 sites in the Waikato Region.

2 Study Sites

2.1 Indicator Sites

All of the REMS sites sampled in the summer of 2000 were used for the indicator analyses (Figure 1).

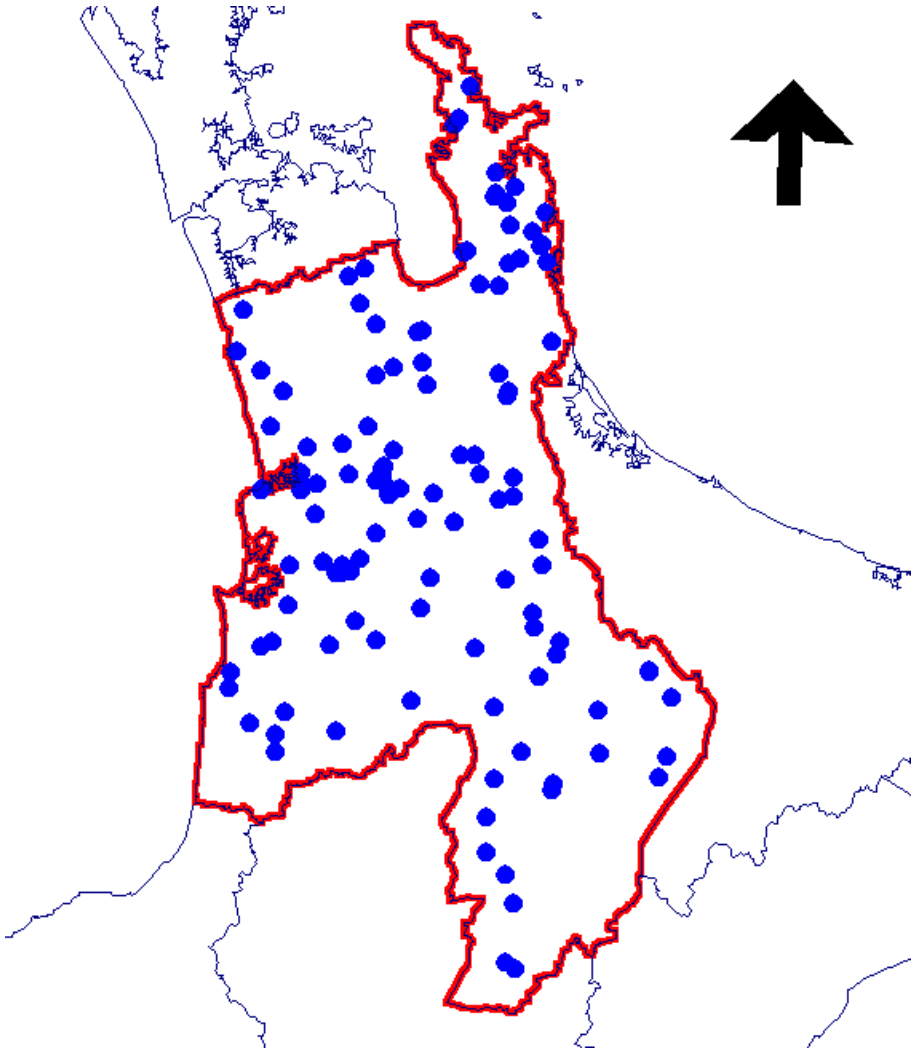


Figure 1: 123 REMS sites collected in the year 2000 sampling period.

The REMS sites can be broken into four distinct areas:

1. Coromandel Streams and associated ranges – these streams in the upper parts of the catchments are predominantly in near native catchments. The streams tend to have a wide variety of highly sensitive taxa present with cobbly substrates and cold water temperatures. There is a wide variety of habitats available to both invertebrates and fish with riffle, run, pool sequences common. Sites in the lower parts of the catchment are often in pasture and hence have less riparian protection, warmer water temperatures and more pollution tolerant taxa present.
2. Hauraki Plains – these streams tend to be dominated by soft sedimentary substrates with the key habitat for invertebrates often the macrophytes on the edges of the channel and any woody debris/snags. The catchment vegetation for most of these streams is dominated by intensive pastoral landuse. Riparian vegetation is often minimal or lacking in these catchments.

3. West Coast – the West Coast streams are in catchments with often extensive pastoral farming. The hilly topography provides a variety of habitat for the invertebrate taxa with a wide variety of substrates present – ranging from the soft to more cobbly substrates. The taxa present in these streams vary with the catchment development and habitat types – they range from the more sensitive to pollution tolerant taxa.
4. Taupo area – the Taupo streams in the upper catchments are often in a near natural state with highly sensitive taxa present. The streams are often dominated by pumice type substrates that make the streambeds highly mobile and unstable. This often substantially reduces the available habitat present and invertebrates are often found most abundantly in the woody debris and other snags in these streams.

2.2 Trend Analyses Sites

Sites were chosen on the basis of being collected consecutively over three years – 43 sites fitted this criteria are included in the analysis. 32 of the sites are in pasture, 10 in native bush and one in exotic forestry catchments (Figure 2).

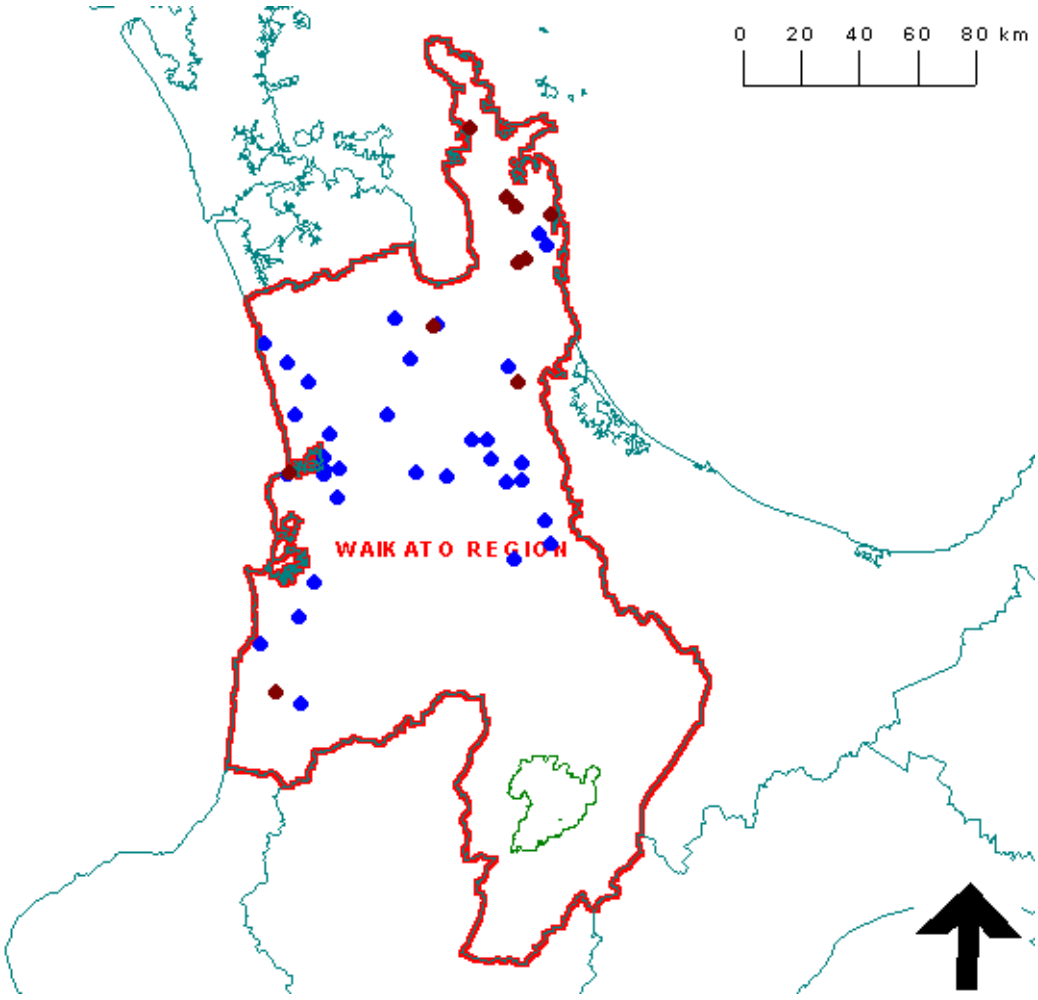


Figure 2: 43 sites for the Waikato Region. Blue dots represent pasture sites, brown = native bush/exotic forestry.

The majority of the sites in native bush catchments were in the Coromandel area, pasture sites were predominantly located in the Hauraki Plains. There were also a number of sites located in pasture catchments on the West Coast.

3 Methods

Samples were collected from the streams using a D-frame dip net with a 200μm mesh. Samples were taken of all available habitats in the stream in proportion to their occurrence. The sampling effort was to collect as a minimum 100 organisms. Samples were then transferred into storage pottles and preserved with 70% ethanol in the field. Samples with excessive amounts of organic matter and debris were also refrigerated to slow putrefaction until sorting. Invertebrate samples were sub-sampled until at least 120 identifiable organisms were sorted. Scans were also made for rare taxa. Identification was done using a dissection microscope (40×) to genus level (where possible) excluding oligochaetes and chironomids that were grouped together.

10% of all the samples were for QA/QC checks whereby another person for accuracy of identification and recording checked the identification of the invertebrates.

Concurrent with the invertebrate collection – information on the instream structure (substrate composition etc.), and catchment characteristics were also recorded.

3.1 Statistical Analyses

3.1.1 Indicator Analyses:

A multimetric analyses was carried out on the data to produce an indicator of the 'health' of the streams in the Waikato Region - this is based on a modified USEPA protocol. The methodology for the production of this indicator is outlined and detailed on the indicator section of the Environment Waikato internet site[1].

Streams were also divided into 'developed' and 'undeveloped' classes – undeveloped streams have no catchment development upstream of the sampling point and are located in native bush. The analysis also divided up the Region into seven major catchment areas as a means of broadly classifying areas in the Waikato Region (Environment Waikato, 1998).

3.1.2 Trend Analyses:

Four metrics were used to assess the changes in the macroinvertebrate communities of the 43 sites over the three years:

1. Macroinvertebrate Community Index (Stark, 1985) – this index is calculated by assigning predetermined sensitivity values to individual species between one and ten (ten = most sensitive taxa), values are then averaged and multiplied by a constant (20).
2. Species diversity – the number of taxa present in a sample.
3. Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (EPT) index – these three groups of taxa are generally sensitive to pollution and so higher values are indicative of good water health. The trichopterans Paroxyethira and Oxyethira were omitted from this index as these taxa are regarded as pollution tolerant and hence are not characteristic of this index.
4. Percent Ephemeroptera – mayflies are sensitive to pollution and hence the higher the proportion of mayflies recorded indicates a stream with better water quality.

A two sample T-test was performed on the indice data to test if there were any significant differences between years of sampling and between developed and undeveloped sites using Data Desk (1992).

[1] http://www.ew.govt.nz/ourenvironment/indicators/inlandwater/riversandstreams/riv3/keypoints.htm

4 Results

4.1 Indicator Results

The majority of the streams surveyed in the Waikato Region were classified as unsatisfactory (Figure 3). The satisfactory streams in the Region tended to be located in the upper parts of the Coromandel and the lower parts of the Region in bush catchments. There were only five streams classified as excellent – the highest concentration of these streams was located in the Pirongia catchment.

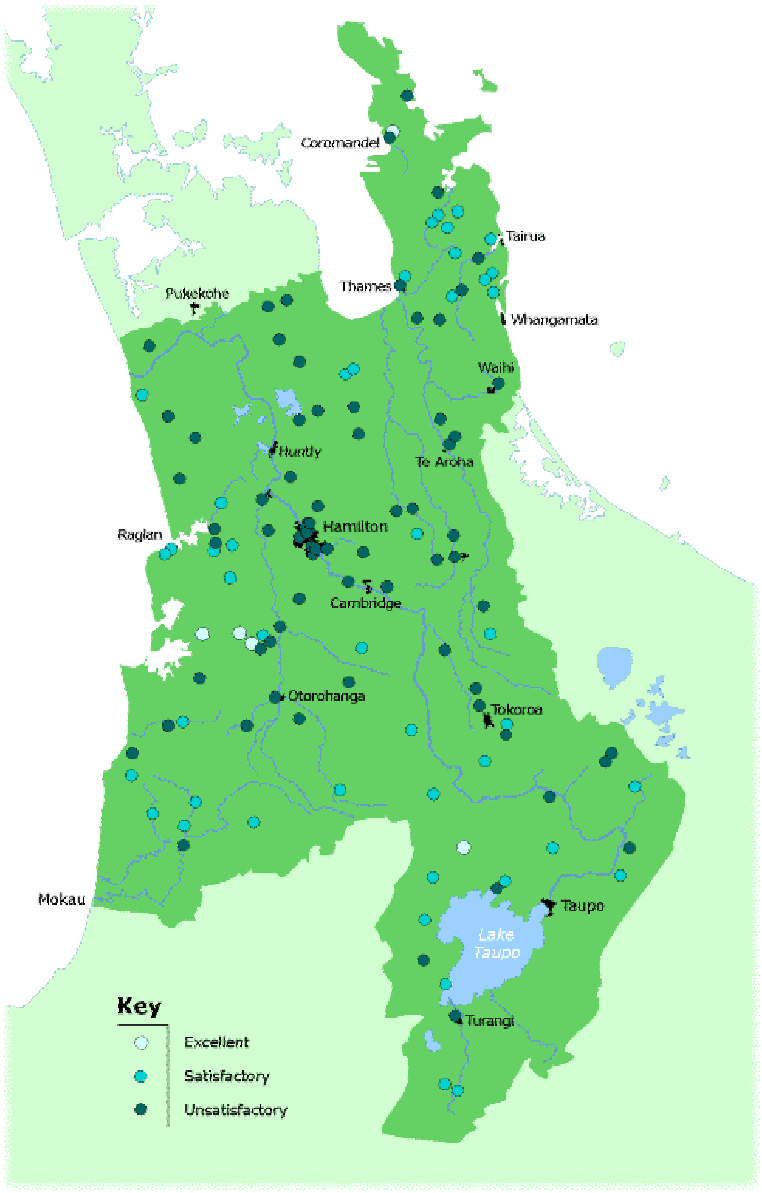


Figure 3: Site Locations and health for all the 123 sites monitored in 1999/2000.

Streams in the undeveloped catchments were predominantly in a satisfactory condition with the exception of 4 streams in the Coromandel area (Figure 4). These streams have been adversely affected by contaminated mine water that discharges into their catchments. The Upland Waikato, Hauraki and Lowland Waikato catchment areas have no sites that are in undeveloped catchments. There are very few of these undeveloped catchments present in these areas.

The developed catchments had a much higher proportion of streams classified as unsatisfactory because of the generally poorer water and habitat quality of these streams.

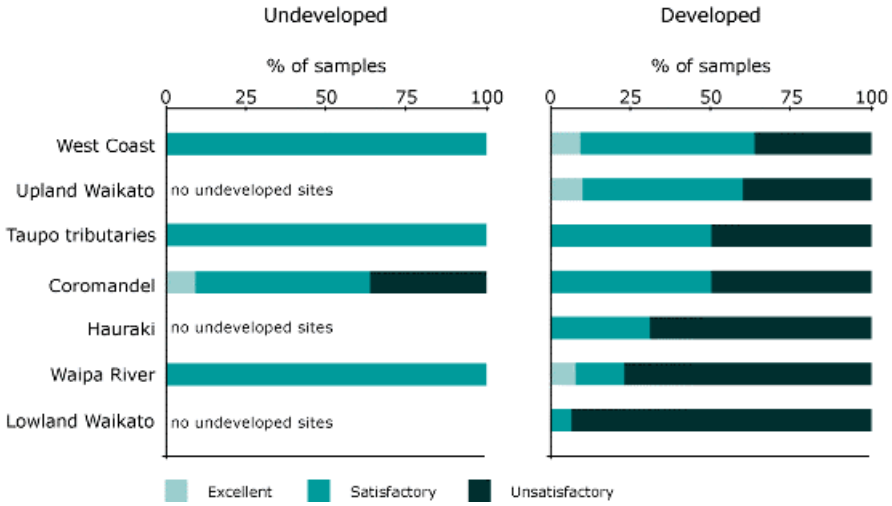
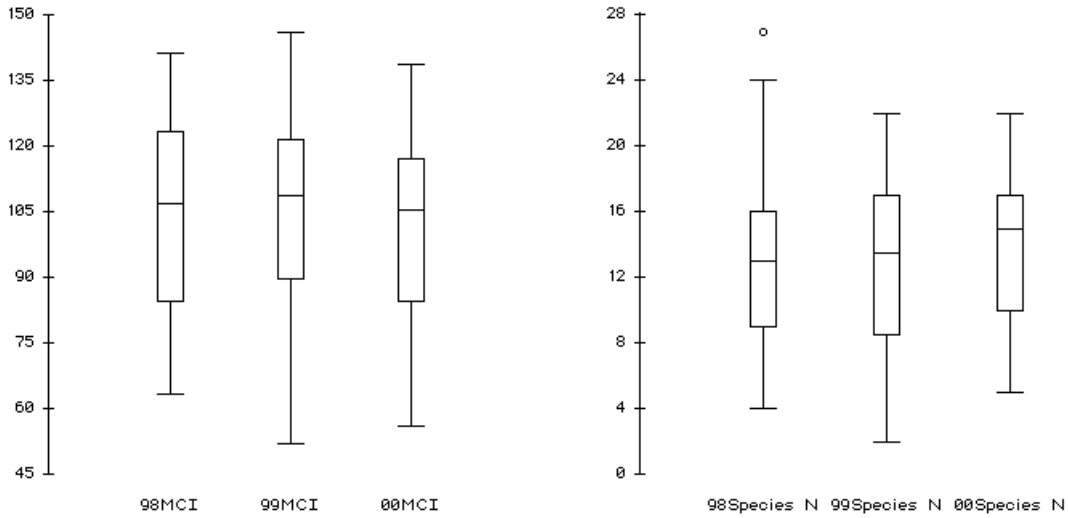


Figure 4: Classification of streams in developed and undeveloped catchments.

4.2 Trend Results

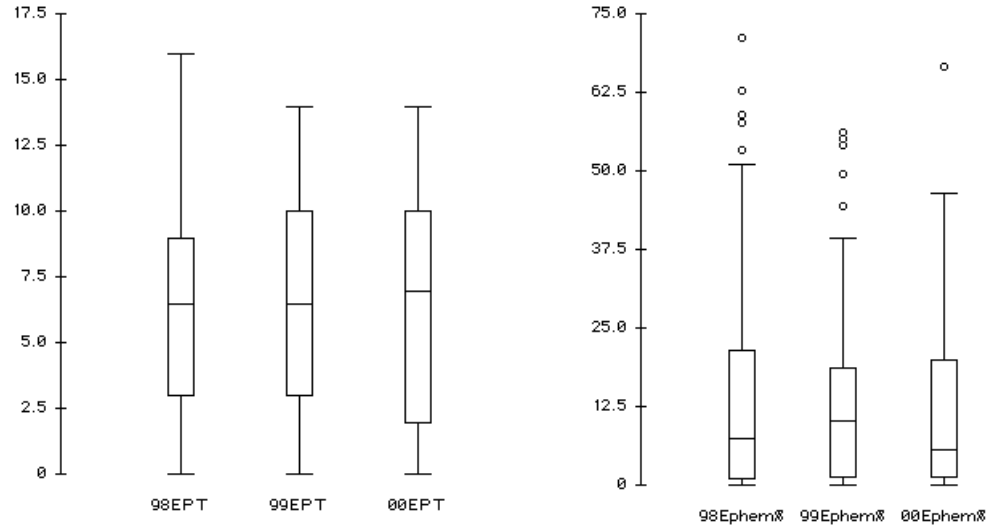
MCI scores for the three years ranged from 52 to 141 (Figure 1), species number ranged from 2 to 27. The average values for both of these indices are very similar between years, and no significant differences were found between all of the years.



(a) (b)

Figure 5: (a) MCI and (b) Species diversity for the 43 sites sampled over three years from 1998 to 2000.

EPT scores ranged from zero to 16, ephemeroptera range from zero to 71% (Figures 6a,b). Similar to the other indice results, there were no significant differences found between years for either of these indices.



(a) (b)

Figure 6: (a) EPT and (b) Ephemeroptera % for the 43 sites sampled over three years from 1998 to 2000.

MCI scores for pastoral streams ranged from 52 to 141, native streams from 85 to 146. The MCI scores for streams in both native and pastoral catchments (Figure 7) showed significantly higher scores in the native catchments ($P<0.0001$). Some of the streams in the pastoral catchments showed high MCI scores (>120), which is unexpected for these types of catchments. This was most likely for streams that only have a small proportion of pastoral development or have a native catchment upstream in close proximity.

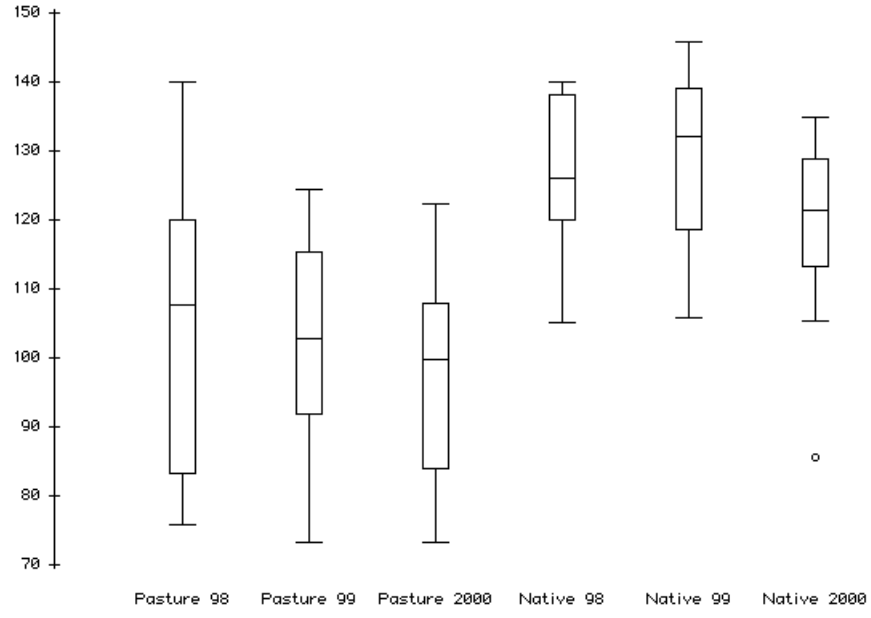


Figure 7: MCI scores for pasture and native streams sampled from 1998-2000.

EPT scores for the pastoral catchments ranged from 0 to 13, native catchments ranged from 2 to 16. The EPT scores for streams in native and pastoral catchments (Figure 8) were significantly different ($P<0.0001$). The native streams surveyed from 1998 to 2000 increased in their range to overlap substantially with the pastoral streams range

of scores. The pastoral streams showed no real changes with a fairly consistent range and average scores.

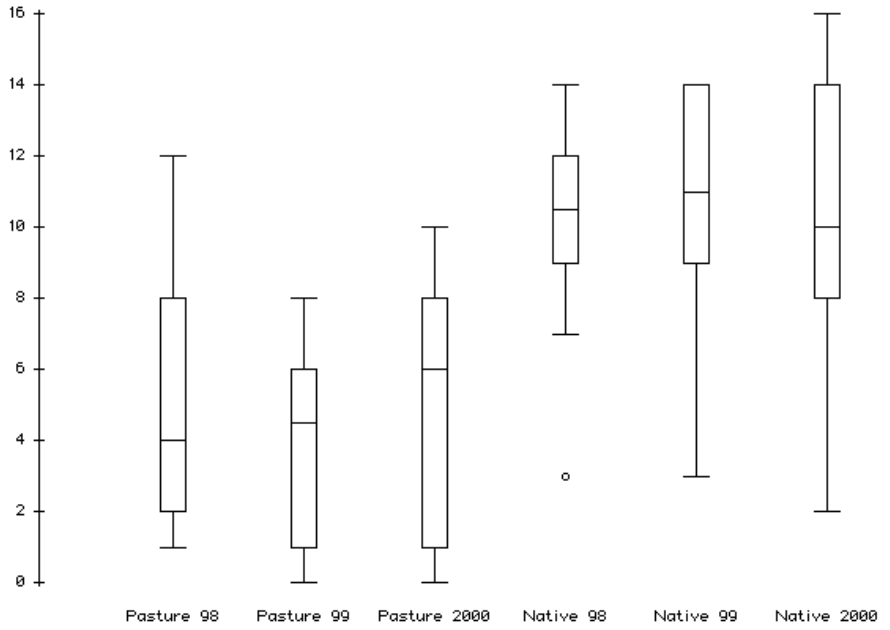


Figure 8: EPT scores for pasture and native streams sampled from 1998-2000.

5 Discussion

The multimetric indicator used in the REMS programme shows that most of the sites in the Waikato Region were classified as unsatisfactory in their ecological condition. The most degraded sites tend to be grouped in the lowland developed areas in the Region e.g., Hauraki Plains. The Upland Waikato, Hauraki and Lowland Waikato streams had no undeveloped sites – the developed sites were generally classified as unsatisfactory. These areas have intensive landuse adjacent to the streams and often have their entire catchments in developed land. Riparian vegetation is often minimal or absent, streams fluctuate highly in temperature and often have large sediment inputs and so only the more tolerant stream invertebrates are able to live in these environments (Quinn & Hickey, 1990). The streams located in catchments with little or no development showed more streams classified as either satisfactory or excellent. These streams tended to be in the more highly elevated, steeper lands where pastoral development is largely impractical.

Hamilton's urban streams were generally classified as unsatisfactory – this is a result of both natural and human induced changes in these streams. A number of the urban streams in Hamilton City have natural upwellings of water rich in anoxic iron. This iron then precipitates out onto the substrates when it is oxidised. This precipitate is particularly harmful to stream invertebrates by clogging their gills and smothering the streambed – significantly reducing the available habitat for colonisation. Urban streams are also often subjected to high sediment discharges (Scott *et al*., 1986) and high volumes of stormwater discharge from the impervious catchments, both of which adversely affect the stream biota. Stormwater discharges can contain a variety of toxic substances e.g., lead that can also adversely affects the stream biota (Garie & McIntosh, 1986). As a result the stream fauna is often limited to only those pollution tolerant taxa e.g., oligochaetes and molluscs.

The multimetric index used in this analysis is well suited to reporting the relative health of the streams in the Waikato Region and condenses a large volume of data into information that is readily understood. Future development of indicators of stream health will need a relatively clear reporting format to ensure the public can understand the information presented.

The metrics used to examine trends in the three-year dataset showed very similar distributions in the scores each year. No significant differences between years were detected for any of the four metrics for the 43 sites. There are a number of possible explanations as to why there was no observed change:

1. Firstly there has been little change in the catchments of these streams over the three years and it hence possible that there has been no change in the invertebrate populations over this time – this is perhaps the most likely explanation,
2. The metrics used on the invertebrate data may not be sensitive enough to subtle changes in the communities over time,
3. The limited temporal nature of the dataset could mean that more years of data is required before any change is likely to be seen,
4. The collection technique (rapid bioassessment) is not sufficiently rigorous to track subtle changes in the invertebrate communities in these streams.

Analysis of both the native streams and the pastoral streams within the three years shows that there are significant differences in the invertebrate communities between these landuses. Both the MCI and EPT scores for these streams showed highly significant differences between these landuses. Interestingly, in 1998 the pastoral stream had a much higher range of values observed for both the MCI and EPT scores. The higher values were comparable with streams in native stream catchments and in some cases higher than the average value for the native streams. EPT scores in particular varied strongly even within the native streams. It seems likely that a number of streams within the Waikato Region with some improvements in their land and

riparian management will be able to attain indice results that are close to those in native streams. This however, will be able to be accomplished in some streams more easily than others. Riparian management is becoming an important part of our land management and it is likely (with careful study and application) to make significant improvements in the quality of our water and aquatic ecosystems.

6 Future Directions for REMS

Currently there are a number of changes that will occur in the near future on both the way the stream invertebrate information is collected from streams and the way the data will be analysed. A working party was set up in the Macroinvertebrate Working Group to look at the way data was collected by all of the Regional Councils nationally. This working group will then come up with a list of recommended techniques for collected samples from both stony and soft-bottomed streams. It is likely that the technique currently employed by the REMS programme will have to be modified to meet the recommendations. There will also be some standardisation of both the sampling protocols and the QA/QC procedures involved. This standardisation of methods is long overdue for New Zealand and will go some distance in allowing comparisons of data between Regional Councils. It is the author's belief that although the technique for collecting the information may change – the previous data collected in the REMS programme will still be in many ways comparable. This means that any change of technique should not be viewed as rendering past data useless.

The analysis of data in NZ has been primarily accomplished through a variety of metrics e.g., MCI. This report and the analysis for the State of the Environment Report for Environment Waikato (Environment Waikato, 1998) shows a step forward by using a combining of metrics or multimetric approach (Barbour et al., 1999, Karr & Chu, 1999). The Environmental Protection Agency has used this technique successfully in the United States of America for some time (Southerland & Stribling, 1995). Other technologies like the predictive modelling approach used in the United Kingdom and Australia show large potential in improving the way we analyse our data. There has until this time been reluctance by some of the science providers in NZ to adopt these new methods. This has resulted in the stalling of progress in the way stream invertebrate data is analysed in NZ, particularly with regard to State of the Environment type monitoring programmes. A trial was undertaken in the Waikato Region to test the predictive modelling approach used in Australia - AUSRIVAS(Australian River Assessment System). The trial concluded that the system would work well for the Waikato Region's streams (Norris & Coysh, 1999). The further development of this system was halted due to a number of scientists who discredited the trial on several minor issues. These issues could have been worked through with the development of a working product for Environment Waikato. The trial was essentially abandoned and no progress has been made on the development of predictive models for NZ streams since that time.

Habitat, catchment and photographic information have also been collected in the REMS programme. Each of these pieces of information has the potential to be developed into indicators like the multimetric index. These indicators form the key output on vehicles like the internet where Environment Waikato can display the both informative and useful information that it collects to the public. The photographs of the streams has the potential to show long term changes in riparian management practice which in turn can be linked to long term changes in the invertebrate communities. While photographic information cannot be made into a numerical indice, this information is a very useful medium for showing people changes in streams and rivers and their management over time.

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