EFFECTS OF LAND USE AND POINT SOURCE DISCHARGES ON MACROINVERTEBRATE AND PERIPHYTON COMMUNITIES OF THE TARANAKI RING PLAIN.

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ABSTRACT

Macroinvertebrate and periphyton communities were sampled from February 1998 to May 1998 in 83 stream and river sites throughout the Taranaki Ring Plain, New Zealand. Generally as streams descend the mountain, the catchment moves along a continuum ranging from pristine headwater streams with a high proportion of catchment in native forest, through to lowland streams with a high proportion of pasture catchment, draining intensive agricultural and industrial practices which put pressure on water resources. Ordination of sites indicated that the environmental continuum on the Ring Plain corresponds to a gradient of taxa along Axis 1 from clean water mayfly, caddisfly and stonefly taxa (i.e., *Deleatidium* spp., *Coloburiscus*) that prefer headwater streams, through to nutrient tolerant taxa (i.e. *Oxyethira, Nemertea, Potomoprygus*) that prefer lowland streams. This was emphasised by the positive correlation of Axis 1 with altitude and percent native forest and negative correlation with conductivity, chlorophyll a, temperature and BOD (Biological Oxygen Demand). A decline in invertebrate richness (number of taxa, Margarlef's index), and an increase in periphyton richness (number of taxa) and biomass (chlorophyll a) also occurred with distance downstream on the Ring Plain.

Data collected in my study were compared to earlier studies (Taranaki Catchment Commission 1982, 1984; Stark 1982; Hirsch 1958) to examine longer term temporal changes in macroinvertebrate communities. Significant differences in MCI and the SQMCI were found between my study and studies in the 1980's and 1958, as well as differences in percent EPT and the number of taxa between my study and 1980's studies. The decline in biotic indices in my study was also accompanied by a decrease in the abundance of mayfly and sensitive caddisfly taxa (i.e., *Deleatidium* spp., *Coloburiscus*) and an increase in the abundance of Diptera and the more tolerant caddisfly taxa (i.e. *Oxyethira*, *Tanytarsini*), since 1980's studies. Although invertebrate communities in my study that used to be below dairy factories and septic tank discharges were similar to the invertebrate communities in the 1980's

studies, there was a general improvement since the 1958 study. This recovery was reflected in the smaller negative differences in MCI values between sites directly upstream and downstream of discharge points within my study compared to the 1958 study. Temporal changes in water quality were mostly attributed to the intensification of agricultural practices, point source discharges from dairy factories and industry, changes in the flow regime and sand movement.

CONTENTS

GENERAL INTRODUCTION

Since human colonisation of New Zealand, two thirds of the almost complete forest cover has been removed, with about half this occurring in the last 150 years since European colonisation (Pullar and McLeod 1992). The impacts of land use on the health of New Zealand's water has been described by the Minister for the Environment as the most significant environmental issue facing the nation (Upton 1994). Productive land use such as agriculture has been shown to affect many of the characteristics of New Zealand's streams, including flows (Dons 1987; Fahey and Rowe 1992) nutrient and sediment concentrations (Smith et al. 1993), physical habitat (Williamson et al. 1992) and invertebrates (Quinn and Hickey 1990a; Harding and Winterbourn 1995; Townsend et al. 1997).

There have been many changes in attitudes to the assessment of water quality. The concern for ecological values has led to the emphasis on aquatic biota to assess conditions more directly (Norris and Norris 1995). The Resource Management Act (1991) also emphasizes the need for monitoring in order to meet the requirements of the Act (Berry 1995). This requires that discharges to receiving waters do not cause any "significant adverse effects on aquatic life" (sections 70 (regional plans) and 107 (resource consents)). There are advantages to studying the distribution of benthic invertebrates on a routine basis in this respect, they act as integrators of the physical and chemical characteristics of the water and provide a continuous record of environmental quality. The biota is also sensitive to intermittent pollution, which may be missed by chemical or physical surveillance. They are also capable of predicting the synergistic influences of combinations of chemicals on the environment at an early stage (Roper 1985).

Despite the importance and widespread use of stream macroinvertebrate communities for environmental monitoring and impact assessment, few studies have reported on long-term variation in community parameters (Townsend et al. 1987, 1989; Weatherley and Ormerod 1990). Few studies have also examined the interaction of point source discharges and land use on biological communities, rather they have focused on impacts from a combination of diffuse and point source discharges (Maasdam and Smith 1994, Quinn and Hickey 1990a, Harding and

Winterbourn 1995). The objective of this study was to examine the effects of land use and point source discharges on the invertebrate and periphyton communities of the Taranaki Ring Plain, and to reveal whether water quality has changed significantly since surveys by the Taranaki Catchment Commission (1984, 1982), Stark (1982), and Hirsch (1958). This involved a survey of the biological and physicochemical measures of 83 stream sites scattered on the Taranaki Ring Plain. Subsequently, 49 of these sites were compared to studies in the early 1980's, whilst 12 of these sites were compared to studies in 1958.

CHAPTER 1: EFFECTS OF LAND USE AND POINT SOURCE DISCHARGES ON INVERTEBRATE AND PERIPHYTON COMMUNITY STRUCTURE IN THE TARANAKI RING PLAIN.

Abstract. 1. Macroinvertebrate and periphyton communities within 83 stream sites on the Taranaki Ring Plain were sampled between February 1998 and May 1998, to identify whether land use and point source discharges affect biological communities.

2. Ordination of sites indicated a gradient of sites along the first two axes, from those with invertebrates which prefer slow flowing pastoral lowland sites (i.e., *Oxyethira*), through to those with invertebrates which prefer native forest, headwater sites (i.e., *Deleatidium* spp.).

3. Pearson correlation's indicated positive relationships between Axis 1 and altitude and the percent native forest and negative relationships with conductivity, chlorophyll a, temperature and BOD.

4. Biological indices (MCI, SQMCI, percentage EPT) correlated positively with altitude and negatively with temperature, conductivity, chlorophyll a and BOD, whilst percent EPT correlated negatively with turbidity. Margarlef's index and number of fauna correlated negatively with the Pfankuch index, whilst the number of fauna also correlated positively with altitude.

5. The MCI and the percentage EPT at each site declined in a linear fashion as the proportion of native forest decreased, and as BOD increased. Whereas chlorophyll a and the number of periphyton taxa declined in a linear fashion as the proportion of native forest increased.

Keywords. Freshwater invertebrates; periphyton; water quality; land use effects; New Zealand.

INTRODUCTION

Catchment land use has been identified as a major large-scale factor affecting invertebrate community composition in New Zealand streams (e.g., Quinn and Hickey 1990a, 1990b; Scott et al. 1994; Harding and Winterbourn 1995). Human activities alter environmental conditions of freshwater ecosystems and disrupt the natural

change in water quality down a river, thereby modifying the structure of aquatic communities (Camargon 1992). Agriculture is perceived to be one of the main causes of degradation of New Zealand's inland waters (Smith et al. 1993). Lowland streams drain some of the most intensively used land which are therefore stressed by wastewater discharges, abstraction, removal of riparian shading, non-point pollution (Wilcock et al. 1995) and disturbance by livestock (Williamson et al. 1992).

A greater degree of pasture development within a catchment may increase sediment inputs (Dons 1987; Wilcock 1986) resulting in the loss of benthic invertebrates due to the smothering of the river bed and DO reductions (Ryan 1991). Dairy shed effluent represents a potentially large impact on receiving waters (Hickey et al. 1989). Organic loading from point-source discharges may result in river deoxygenation (Hickey et. al. 1989), whilst nutrient additions may promote nuisance algae growths (Rutherford et al. 1987), and ammonia can reach levels toxic to invertebrates and fish. Greater pasture development may also increase light with consequent higher temperatures (Beschta and Taylor 1988) which could be detrimental to some species of stoneflies and mayflies (Whitney 1939; Nebeker and Lemke 1968).

Streams draining intensively farmed arable land have lower invertebrate taxonomic richness (Hynes 1960; Mason 1981; Harding and Winterbourn 1995), less enrichment-sensitive taxa (e.g, mayflies and stoneflies), which are replaced by more tolerant taxa (Welch et al. 1977; Dance and Hynes 1980; Lenat 1984, 1988; Quinn and Hickey 1990a; Quinn and Hickey 1992; Scott et al. 1994; Harding and Winterbourn 1995; Lenat and Crawford 1994), and an increase in biomass of grazing invertebrates (Towns 1981; Behmer and Hawkins 1986).

Despite the development of 36% of New Zealand's land area to improved pasture (Rutherford et al. 1987), the point source discharge aspect of land use on biological communities, has often been neglected within New Zealand. Hirsch (1958) studied the bottom faunas of severely polluted New Zealand streams immediately above and below major point source discharges. Whilst Suckling (1982) investigated the effects of organic wastewater discharges on the benthic fauna of the Manawatu River. Yet recent studies concerning the effects of nutrient enrichment on stream macroinvertebrates, have focused on nutrient inputs from both subsurface flow and point source discharges (Maasdam and Smith 1994; Quinn and Hickey 1990a;

Harding and Winterbourn 1995). However the addition of nutrients from diffuse sources, may disguise the effects of point source discharges on benthic stream communities.

The aim of this study was to investigate invertebrate and periphyton communities of Taranaki Ring Plain streams draining catchments within a gradient of land use change (i.e., native forest, forest remnant, pasture), and point source discharges (i.e., dairy and industrial).

STUDY AREA

The Taranaki region is characterised by high rainfall, with temperatures modified by its coastal location. Annual rainfall varies markedly throughout the region, from approximately 1500 mm in coastal areas to over 6500 mm on land 1000m or more above sea level. The Taranaki region lies on the West Coast of the North Island, extending along 230 kilometres of coastline (Taranaki Regional Council 1998). There are 69 major catchments within the region and about 2300 kilometres of rivers over 3 m in width (Taranaki Regional Council 1995c).

The region comprises two distinct river systems; the radial, Ring Plain waterways which have their headwaters in the Egmont National Park and those rivers which drain sandstone and mudstone hill country in eastern Taranaki (Ministry of Agriculture and Fisheries 1993). The greatest density of rivers flow from Mount Egmont across the Ring Plain in a distinctive radial pattern. More than 100 rivers emerge from the Egmont National Park, increasing threefold as they branch towards the sea (Taranaki Regional Council 1995c). Mount Egmont has intact native forest down to an altitude of c. 400-m a.s.l. As the streams have similar gradients they emerge at similar altitudes from native forest into farmland predominantly of dairying land use (Joy 1999).

I sampled 83 sites from 27 waterways scattered on the Taranaki ring plain (refer to table 1, figure 1). Rivers of the region are characterised by short narrow catchments with steep gradients and well-incised river channels (Taranaki Regional Council 1995c). The rivers are also generally fast flowing, with stony streambeds.

Table 1 Location of 83 Ring Plain sites surveyed between February and May 1998.

River/Stream	Location	Site No.
Inaha S.	600m d/s Palmer Rd	A1
	2.1km d/s Palmer Rd	A2
	3.5Km d/s Eltham Rd	A3
	Normanby Rd Bd	A4
	SH45	A5
	150m d/s SH45	A6
Kaihihi S.	SH45	B1
Kahouri S.	2km u/s of SH3	C1
	SH3 Bd	C2
	d/s Flint Rd Bd	C3
	20m u/s of Piakau S. Confl.	C4
Kapoaiaia S.	Wiremu Rd, 30m u/s of Bd	D1
	Immed. U/s Pungarehu Dairy Fact.	D2
	100m u/s SH45	D3
	SH45a below Pungarehu Dairy Fact.	D4
Kaupokonui R.	Opunake Rd	E1
	250m u/s Kaponga oxp discharge	E2
	50m d/s Kaponga oxp outfall	E3
	1km d/s Kaponga oxp discharge	E4
	Skeet Rd Bd	E5
	Upper Glenn Rd	E6
	SH45	E7
Kapuni S.	Opunake Rd	F1
	Eltham Rd	F2
	Skeet Rd	F3
	SH45	F4
Manganui R.	3km u/s SH3	G1
	400m u/s Tariki Rd	G2
	300m d/s Tariki Power Diversion Weir	G3
Mangahume S.	Wiremu Rd Bd	H1
	Eltham Rd	H2
	SH45 Bd	H3
Maketawa S.	Opp. Denby Rd (2.2 km d/s National Park	I1
	SH3	I2
Mangaoraka S.	2km u/s Kaimiro	J1
	Opp. Union Rd	J2
	Devon Rd (SH3)	J3
Ngatoro S.	SH3	K1
Oaonui S.	Wiremu Rd 15m u/s of Bd	L1

	SH45	L2
Oakura R	Carring Rd, 20m u/s of Bd	M1
	SH45, 300m u/s of Bd	M2
Timaru S.	Carrington Rd	N1
	SH45, 100m u/s of Bd	N2
Otahi S.	Wiremu Road	01
	U/s Opunake Dairy Factory, SH45	02
Otakeho S.	Opunake Rd	P1
	Skeet Rd	P2
	50m d/s Skeet Rd	P3
	SH45	P4
Patea R.	Barclay Rd Bd	Q1
	Cardiff Rd Bd	Q2
	Brecon Rd	Q3
	500m u/s of Kahouri S. Conf.	Q4
	Skinner Rd Bd	Q5
Punehu S.	Opunake Rd	R1
	500m d/s Mangapapa S. Confl.	R2
Stony S.	Near end of Saunders Rd	S1
	Wiremu Rd	S2
	SH45	S3
Te Popo S.	SH3, Midhurst	T1
Waiau S.	Wiremu Rd 10m d/s of Bd	U1
	Approx 250m u/s SH45 Bd	U2
Waiongana S.	Adj. Egmont Rd	V1
	2km u/s SH3	V2
	SH3A Bd	V3
	Manutahi Rd	V4
Waingongoro R.	Opunake Rd	W1
	End of Clifford Rd	W2
	350m d/s Riverlands discharge	W3
	Skeet Rd	W4
	300m u/s Mawhitiwhiti Rd	W5
	150m u/s SH45	W6
Waiwakaiho R.	Alfred Rd Track	X1
	700m u/s Confl. of Kaiauai S.	X2
	Burgess Park	X3
	60m u/s rimu St landfill	X4
Warea S.	Wiremu Rd, 20m u/s of Bd	Y1
	SH45 bd	Y2
Waitara R.	Bertrand Rd	Z1
	U/s Waitara Landfill	Z2
Waiweranui S.	Wiremu R, 100m d/s Bd	AA1
	SH45	AA2

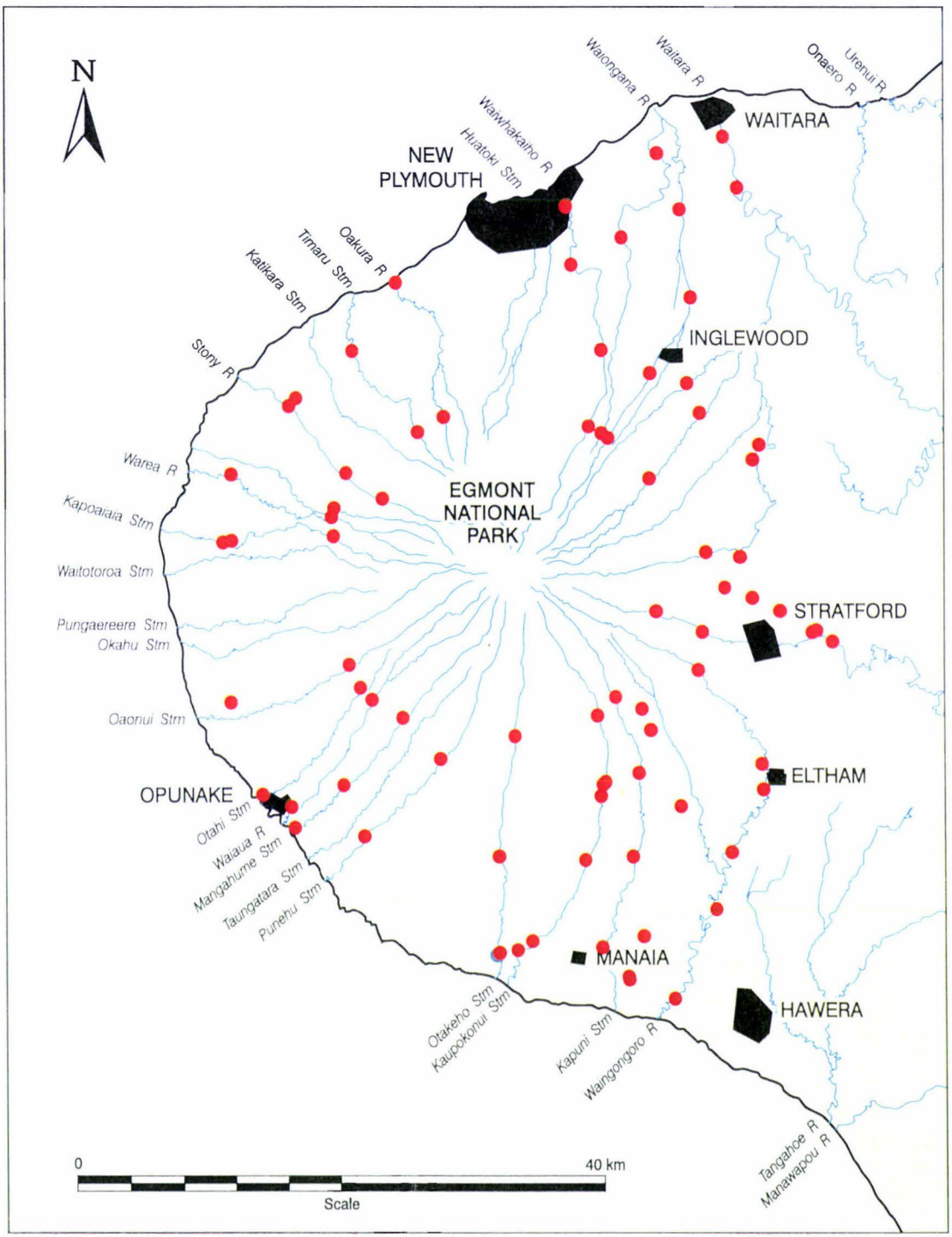


Figure 1 Location of 83 sampling sites on the Taranaki Ring Plain.

MATERIALS AND METHODS

Environmental Measurements

Sampling was conducted between February and May 1998. Mean depth was calculated from 10-15 depth measurements taken along a transect at two locations within a 2 m reach. The number of stream width measurements taken ranged from 2-4, and was dependent on the heterogeneity of the stream channel at each site. For instance a curved reach may require 4 measures compared to a straight reach which may require only 2 measures. Water temperature was measured with a calibrated thermometer in the riffle where sampling took place. The composition of sediment on the streambed, was visually assessed as the percentage cover of: silt (<0.063mm); sand (0.064-2mm); gravel (2.1-60mm); small cobble (61-120mm); large cobble (121-260mm); boulders (>261mm); and bedrock. These were converted to a single index (substrate Index = 0.08 boulders % + 0.07 large cobbles % + 0.06 small cobble % + 0.05 gravel % + 0.04 sand % + 0.03 silt %) following Jowett and Richardson (1990) and Jowett et al. (1991) to give a value between 3 and 8, with higher scores representing larger particle sizes.

The Pfankuch index (Pfankuch 1975) was used at each site, to evaluate reach stability. This involves summing the scores assigned to 15 attributes in three regions of the stream channel, i.e., upper banks, lower banks and stream bottom.

1 L water samples were collected at each site during sampling, slicker pads kept samples cool until their return to the laboratory for chemical analysis, based on Greenberg et al. (1992). Conductivity was measured with a Jenway 4010 meter and expressed as mSm^{-1} at 20°C. pH was assessed with a PHM64 pH meter and turbidity was measured using a 2100A turbidimeter and expressed in nephelometric turbidity units (NTU). Altitude and upstream catchment land use were determined from a 1 : 50 000 topographical map (New Zealand Survey and Land Department 1989, NZ260). The catchment boundaries for each stream site, and the area of catchment in each land use category (native forest and forest remnant, riparian, pasture), were drawn onto topographical maps. These were scanned into Farm Tracker for windows (1998), which is designed to calculate specified areas of land once a scale has been set. Boundaries were retraced into Farm Tracker, and a scale equivalent to the topographical maps specified. Sites were grouped into 4 categories based on their

percentage of native forest (0-25%, 26-50%, 51-75%, 76-100%) for statistical analysis. The total accumulation of point source discharges to water were quantified from resource consents upstream from each site. These were grouped into discharge type (i.e., dairy, piggery, municipal), then each volume was expressed in m^3/day, multiplied by the BOD and suspended solids concentration (conveyed in gm^{-3}) applying to the discharge type, and expressed in kg/day. Sites were grouped into 3 categories based on the accumulation of BOD from point source discharges (0-5.6, 5.7-30, >30) for statistical analysis. Point source discharges within 1 and 2 km upstream of each site were also examined to evaluate whether distance from the discharge correlated with macroinvertebrate community characteristics.

An estimate of epilithic biomass was obtained for each site by extracting photosynthetic pigments from five randomly collected cobbles (each about $24cm^2$). A caliper was used to obtain the length, width and height of each stone and surface area was calculated using the method of Graham et al. (1988). The stones were soaked in 90% acetone for 12 h at 5°C in the dark to extract pigments. Samples were placed in the spectrophotometer and read at: 750, 665, 645 and 630 nm. Chlorophyll a was calculated in mgm^{-3} using the following monochromatic equation by Pridmore et al. (1981):

$$\text{If } D665b/D665a < 1.65,$$

Where D665a = absorbance at 665 nm after acidification, and D665b = absorbance at 665 nm before acidification, then:

$$\text{Chlorophyll a} = \frac{26.7\,(D665b - D665a) \times \text{Volume extract (L)}\; V_E/V_sL}{\text{Surface area (m2)}}$$

where Vs = volume (in litres) of water filtered for extraction, VE = volume (in ml) of extract, and L = pathlength (in cm) of cuvette.

Invertebrate and periphyton sampling

At each of the 83 study sites, 400ml of material were collected by kick sampling into a 0.5 mm mesh net. Each sample was preserved with 100ml of Kahle's solution or ethyl alcohol. Invertebrates were identified to genus level using the keys of Winterbourn and Gregson (1989), and Cowley (1978). Taxonomic richness was

recorded as very abundant (VA) over (approx.) 500 animals collected, abundant (A) 20 or greater, common (C) 19 or less, and rare (R) 5 or less. Periphyton samples were taken from the tap water originally sifted through kick net samples at each site. Periphyton was identified with a compound microscope to family level using keys of Entwistle et al. (1997) and Bold and Wynne (1978).

Index measures

Species diversity was assessed with:

1) The Margalef index (Clifford and Stephenson 1975), a simple measure of species richness given by:

$$D = (S-1) / \ln N.$$

where N is the total number of individuals collected and S is the number of taxa.

2) Simpson's index (Simpson 1949), an evenness measure and has the form:

$$Ds = \sum [n_i (n_i-1)] / [N (N-1)]$$

where n_i is the number of individuals in the i^{th} species and N is the total number of individuals collected. The Simpson's index is strongly weighted towards the most abundant species (Death and Winterbourn 1995).

3) The Macroinvertebrate Community Index (Stark 1985a) assesses the tolerance of the invertebrate community to pollution or enrichment and has the form:

$$\Sigma(a_i / n_i) \times 20$$

where a_i is the score of that taxon (assigned a value from 1 to 10, representing grossly polluted to very clean conditions respectively) and n_i is the number of individuals of the ith scoring taxon. A suggested assessment for MCI values is: >120, clean water, 100-120, moderately enriched, <100, severely enriched or polluted.

4) The Semi-quantitative version of the Macroinvertebrate Community Index has been developed by the Taranaki Regional Council (SQMCI), and responds to changes in community dominance. Three abundance-related loading factors have been assigned to the invertebrate counts (R=rare, C=common, A=abundant).

$$SQMCI = \sum_{i=1}^{i=s} \frac{(nixai)}{N}$$

where S is the total number of taxa in the sample, n_i is the coded abundance for the ith taxon (i.e., R=1, C=5, A=20), a_i is the score for the ith taxon and N is the total of the coded abundances for the entire sample.

5) The percentage of EPT assesses the total number of Ephemeropteran, Plecopteran and Trichopteran in an invertebrate sample.

$$\frac{(E+P+T)}{N} \times 100$$

Where N is the total total number of individuals collected.

6) The percentage composition of each family across land uses was calculated by grouping sites in relation to their percentage catchment in native forest (0-25%, 26-50%, 51-75%, 76-100%) and then summing each family from each land use group by adding scores assigned to each animal based on their abundance related categories (rare = 3, common = 12, abundant = 200 and very abundant = 600). The sum of each family was then divided by the total number of animals within each land use group and presented as a percentage of each group.

7) The percentage composition of each taxa was calculated for sites grouped by the percent native forest catchment (0-25%, 26-50%, 51-75%, 76-100%) and BOD from point source discharges (0-5.6, 5.7-30, >30). Each taxa was summed using the abundance related categories, and then divided by the total number of animals within each land use group and presented as a percentage of each group.

Statistical methods

Macroinvertebrate community data was related to environmental and chemical data using ordination with SYSTAT (1998). Rare taxa were downweighted with the covariance technique to reduce their influence in the ordination. Pearson correlations with Bonferroni adjustments were performed with the environmental and chemical variables, to investigate relationships with invertebrate community composition. The critical probability level was set at 0.05 in the correlation analysis.

The biological indices for macroinvertebrate (MCI, percentage EPT, Margarlef Index) and periphyton (chlorophyll a, number of taxa) communities across sites in relation to their proportion of catchment in native forest and BOD

concentrations, were included in a linear regression analysis to yield predictive equations for community structure. BOD data was log transformed.

An ANOVA was performed with SYSTAT (1998) to examine if differences in macroinvertebrate (Margarlef's Index, Simpson's Index, taxa number, MCI) and periphyton (chlorophyll a, number of taxa, abundance) communities were different over sites grouped in relation to BOD (0-5.6, 5.7-30, >30) and the percentage of native forest (0-25, 26-50, 51-75, 76-100).

An ANOVA was also performed on families within sites grouped by percentage of catchment in native forest, to find out if faunal groups differed over land use. The number of taxa within each family were calculated by summing the scores assigned to each animal based on their abundance-related categories (rare=3, common=12, abundant=200, very abundant=600).

RESULTS

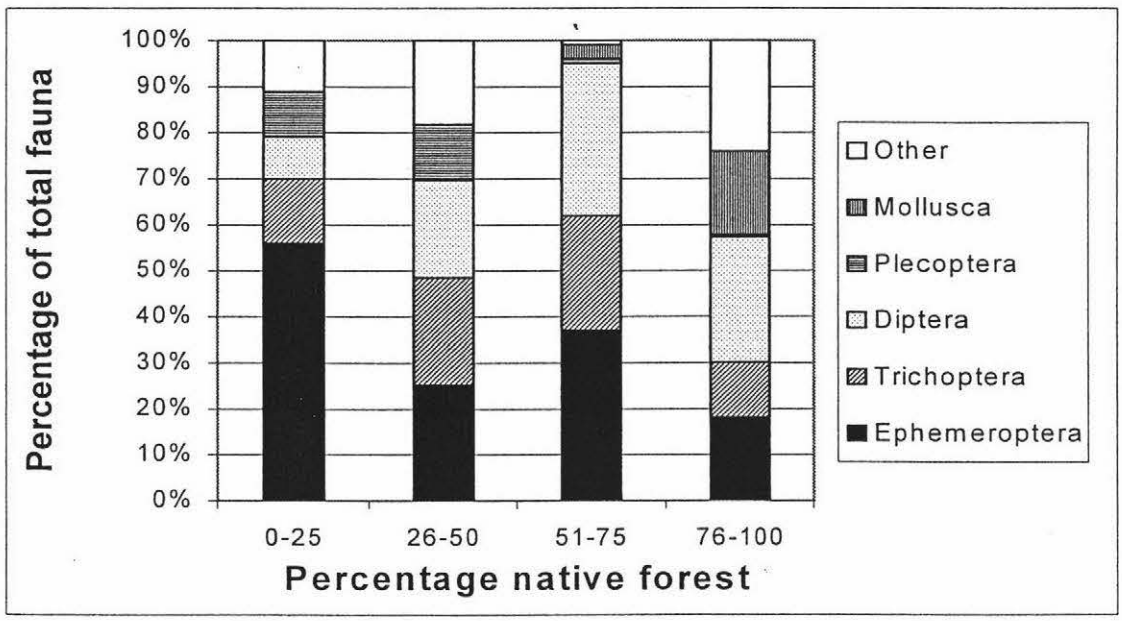
Macroinvertebrate community composition

Taxonomic diversity (Margarlef's index, Simpson's index) was similar across all Ring Plain sites grouped by proportion of native forest catchment (ANOVA, $P>0.05$, $F_{3, 79}=2.2$ and $F_{3, 79}=1.6$ for Margarlef's and Simpson's index respectively), and BOD level (ANOVA, $P>0.05$, $F_{2, 80}=1.3$, $F_{2, 80}=0.32$ for Margarlef's and Simpson's index respectively). The majority of fauna at sites with a high percent of native forest catchment (76-100%) were Ephemeroptera (56% of highly forested catchments) (Fig 2), which were less abundant in the pastoral lowland streams (18% of pastoral lowland lowland catchments) (ANOVA, $P<0.000$, $F_{3\ 79}=7.69$). Trichoptera were equally abundant across catchment land uses (ANOVA, $P>0.05$, $F_{3, 79}=0.36$), however streams with a high percent of pasture were dominated by *Oxyethira albiceps* and *Aoteapsyche* taxa. Plecoptera were found mostly in streams with a high percent of native forest (10% of highly forested catchments), and were generally absent from streams with a high percent of pasture (ANOVA, $P=0.000$, $F_{3, 79}=9.65$). In contrast, streams with a low percent of native forest (0-25%) had more Diptera (27%) and molluscs (18%) than forested headwater streams (ANOVA, $P=0.002$, $F_{3, 79}=5.52$, $P=0.001$, $F_{3, 79}=6.01$ for dipteran and molluscan species). Taxonomic richness (number of taxa) was similar across all Ring Plain sites grouped by native forest catchment (ANOVA, $F_{3, 79}=0.12$, $P>0.05$) and BOD ($F_{2, 80}=1.2$, $P>0.05$), although the richest communities were recorded at forested headwater sites (site AA1 had 37 taxa; site V1 had 36 taxa).

Deleatidium spp. numerically dominated streams with a high percent of native forest (76-100%) (46%) and low BOD (0-5.6) (38%), whilst *Elmidae* were recorded at all sites with a high percent of native forest and low BOD. *Aoteapsyche* dominated sites with 51-75% native forest (14%) and average BOD (5.6-30) (10%), whilst *Orthocladiinae* and *Elmidae* were found at all sites with 51-75% native forest and average BOD. Streams with 26-50% native forest were dominated by *Elmidae* (17%), which were also found at sites with 26-50% native forest, along with *Orthocladiinae*

and Oligochaeta. Sites with a low amount of native forest (0-25%) were dominated by *Potamopyrgus antipodorum* (17%), which was also found in abundance at sites with a high BOD (>30). High BOD sites were dominated by *Orthocladiinae* (15%). *Deleatidium* spp. was also abundant (14%) at sites with a low proportion of native forest (0-25%), although they were more characteristic of the highly forested sites (ANOVA, P=0.000, $F_{3, 79}$=14.91). *Oligochaeta* were present at all sites with a low percent native forest.

Figure 2 Higher order taxonomic composition of invertebrate communities collected in 83 Ring Plain Streams from February to May 1998, grouped according to percent of native forest catchment.



The MCI and percentage EPT at each site declined in a linear fashion as the proportion of catchment in native forest decreased (MCI- $F_{1,81}$=43.80, P=0.00; R^2 = 0.35, EPT-$F_{1,81}$=50.3, P=0.00, R^2 = 0.38) (Fig. 3). MCI scores were highest in headwater sites draining catchments within 76-100% native forest (mean MCI = 127), and lowest in stream sites within 26-50% native forest (mean MCI = 89), (ANOVA, $F_{3, 79}$=23.2, P=0.000). MCI and the percent EPT at each site also declined linearly as the BOD from point-source discharges increased (MCI- $F_{1,69}$=29.74, P=0.00,

$R^2 = 0.30$, EPT- $F_{1,69}=20.68$, $P=0.00$, $R^2 = 0.31$) (Fig. 4). Margarlefs index was similar between sites in relation to BOD and the percent native forest ($F_{1, 81}=0.01$, $P=0.94$, $R^2=0.00$).

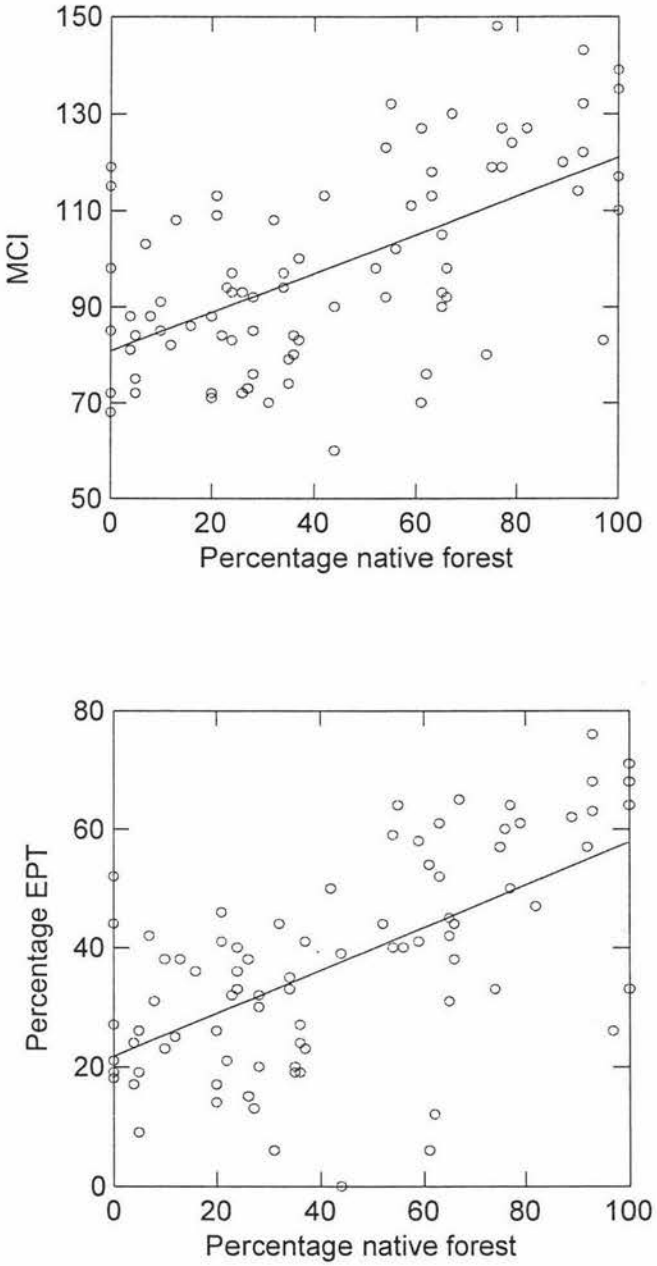
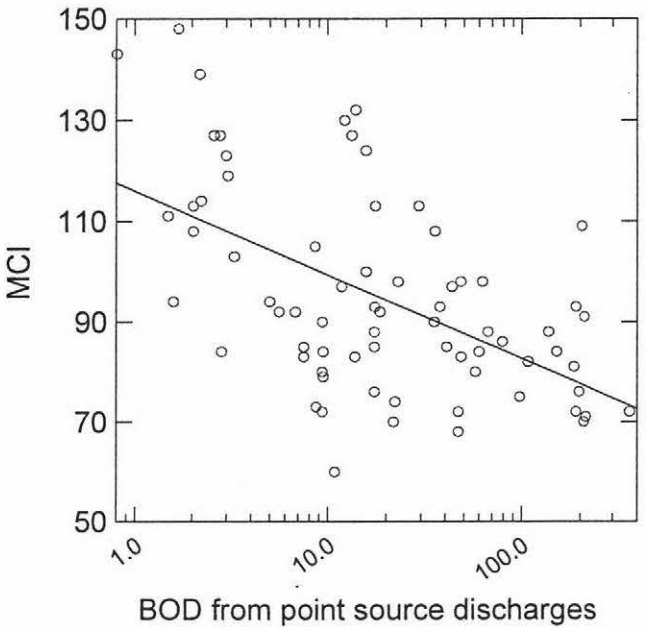


Figure 3 a) MCI b) Percentage EPT versus percentage native forest (regression equation MCI= 80.84 + .402 (20) $R^2 = 0.35$, EPT = 21.74 + .36 (20) $R^2 = 0.38$), for macroinvertebrate samples collected from 83 sites on the Taranaki Ring Plain between February and May 1998.



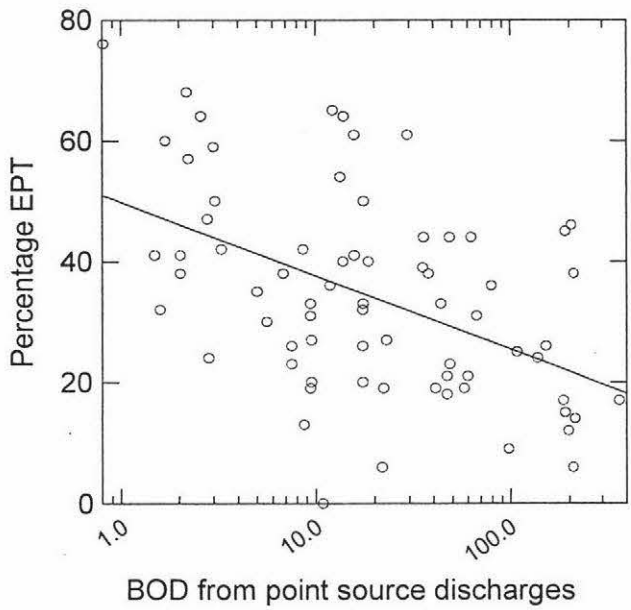


Figure 4 a) MCI and b) percentage EPT versus BOD (regression equation MCI= 116.00 + -16.65 (20), $R^2 = 0.30$, percentage EPT = 49.79 + -12.17 (20) $R^2 = 0.31$), for macroinvertebrate samples collected from 83 sites on the Taranaki Ring Plain

Macroinvertebrate ordination

The macroinvertebrate ordination plot (Fig. 5) grades sites along a continuum along Axis 1, from those sites which have relatively enrichment tolerant taxa on the left, through to those with pollution sensitive taxa on the right. These taxa corresponded to a general continuum from high altitude, unimpacted forested head water streams, where the "sensitive" types are often found, through to open lowland streams influenced by a range of human impacts, where "tolerant" types are more common. Taxa with high positive loadings were *Deleatidium* spp., *Coloburiscus* and *Zelandoperla* which are "sensitive" species, and taxa with high negative loadings were *Oxyethira, Nemertea* and *Potamopyrgus* which are "tolerant" species. Environmental variables that correlated with Axis 1 (Table 2), included altitude and the percentage of catchment in native forest. Negative correlations with Axis 1 included conductivity, temperature, BOD (upstream accumulation of point sources), and chlorophyll a. Biological indices (MCI, SQMCI, percentage EPT, Margarlef's index) were positively related to Axis 1, indicating the preference of sensitive taxa (i.e., caddisflies and mayflies) to headwater streams, and tolerant taxa (i.e. Nemertea, *Oxyethira*) to lowland streams. The MCI, SQMCI and percentage EPT positively correlated with altitude, and negatively correlated with temperature, conductivity, chlorophyll a and BOD, while percent EPT negatively correlated with turbidity. Margarlef's index and number of taxa correlated negatively with the Pfankuch index, whilst the number of taxa was positively correlated with altitude.

Taxa with the highest positive loadings for Axis 2 were *Maoridiamesa, Aphrophila* and *Aoteapsyche*, whereas *Physa, Deleatidium* spp., and *Hirudinea* had high negative loadings. There were significant positive correlations between axis 2 and macroinvertebrate richness (number of taxa, Margarlef Index), whilst negative correlations with Axis 2 occurred with Simpson's Index and the Pfankuch Index (Table 2). Sites with high positive loadings reflected species rich communities with stable environments, while sites with high negative loadings reflected communities with low diversity and unstable environments. A group of sites is evident within the middle lower portion of the ordination plot. These sites have poor community

richness (less than 10 taxa), a high proportion of fine substrates (H1, H2, L1, and L2), or low nutrient inputs (S2, S3). Axis 1 explained 31% of the total variance, whilst axis 2 explained 15%.

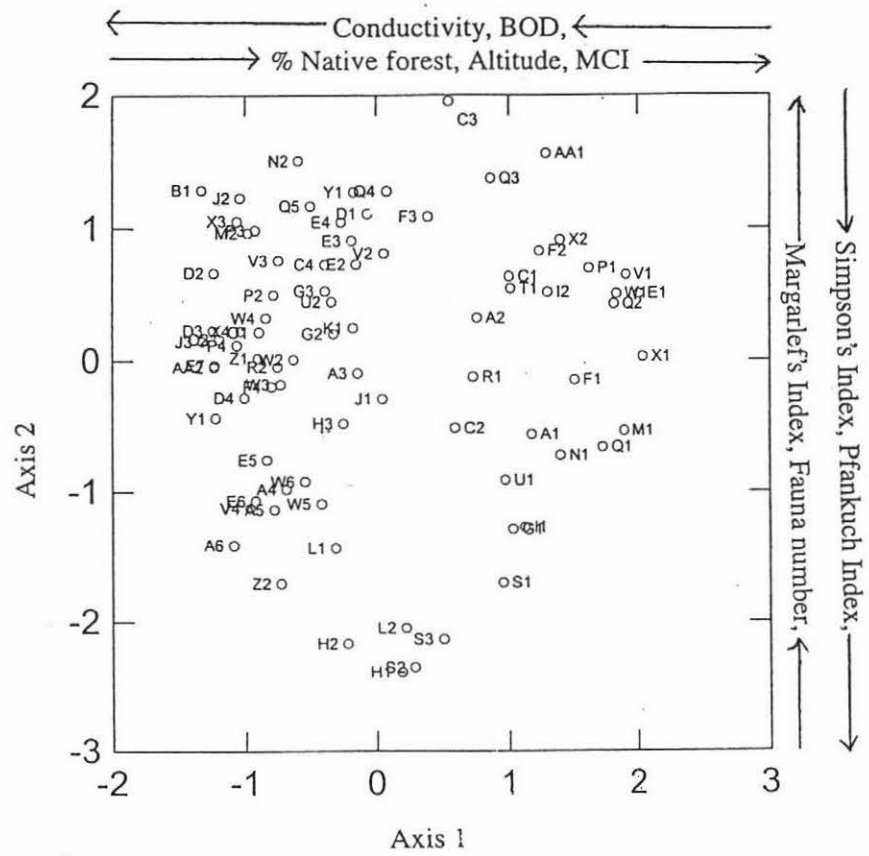


Figure 5 Ordination of macroinvertebrate samples collected from 83 sites on the Taranaki Ring Plain between February and May 1998. Environmental and chemical variables, which correlate significantly with these axes, are shown.

Correlations between land use and environmental and chemical factors

The percent of catchment in native forest correlated positively with altitude, and inversely with BOD from upstream point source discharges, conductivity and turbidity. Site stability correlated positively with upstream catchment in native forest and riparian vegetation. Suspended solids and pH did not correlate with the percent of catchment in native forest (Table 2).

Table 2 Correlation coefficients for biological and physical characteristics of 83 Ring Plain sites sampled between February and May 1998. Significance levels are corrected for multiple comparisons by the Bonferroni method. n.s., not significant, P>0.05; *, P<0.05; **, P<0.01; ***, P<0.001. Variable names and units: ITR = Invertebrate Taxonomic Richness; MAR = Margelef's Index; SIMP = Simpson Diversity Index, PNF = Percentage native forest, SS = suspended solids.

	BOD	PNF	Axis 1	Axis 2
BOD				
PNF	-0.36**			
Axis 1	-0.37*	0.54***		
Axis 2	n.s.	n.s.	n.s.	
MCI	-0.45**	0.59***	0.88***	n.s.
SQMCI	-0.43**	0.59***	0.92***	n.s.
%EPT	-0.45**	0.60***	0.86***	n.s.
ITR	n.s.	n.s	0.43**	0.75***
MAR	n.s.	n.s.	0.39**	0.53***
SIMP	n.s.	n.s.	n.s.	-0.49***
SS	0.043***	n.s.	n.s.	n.s.
Conductivity	n.s.	0.039**	-0.51***	n.s.
Turbidity	n.s.	-0.41**	n.s.	n.s.
PH	n.s.	n.s.	n.s.	n.s.
Temperature	0.051***	n.s.	-0.40**	n.s.
Chl a	-0.35*	-0.35*	-0.48***	n.s.
Width	0.44***	n.s.	n.s.	n.s.
Depth	n.s.	n.s.	n.s.	n.s.
Altitude	n.s.	0.42**	0.84***	n.s.
Pfankuch index	n.s.	n.s.	n.s.	-0.45**
Substrate index	n.s.	n.s.	n.s.	n.s.
Canopy cover	n.s.	n.s.	n.s.	n.s.

Periphyton community composition

Gomphenema occurred in the greatest number of streams at sites across all catchment land use categories and also within sites grouped by BOD from point source discharges (0-5.6, >30). At sites with average BOD (5.6-30), *Nivicula* was found in the greatest number of streams. Periphyton faunas were most diverse in the lowland pastoral sites where a range of diatoms, green algae and blue green algae were found. Diatoms were the most taxonomically diverse, however their biomass was less than the multicellular algae such as *Melosira* and *Oedogonium* species which occasionally formed algal blooms in the late summer months, especially within pastoral streams.

Chlorophyll a and number of taxa at each site declined in a linear fashion as the percent of native forest increased ($F_{1,76}$=9.89, P=0.00; R^2 = 0.12, and $F_{1,58}$=7.69, P=0.00, R^2 =0.12 for chlorophyll a and number of taxa respectively). Taxonomic richness increased in a linear fashion as BOD increased ($F_{1,58}$ =4.06, P=0.05, R^2 = 0.14), whereas chlorophyll a was independent of BOD (Fig. 7). However a significant relationship (ANOVA, P =0.004, $F_{2,75}$ = 5.90, R^2 = 0.14) was found between Chlorophyll a and sites, when they were grouped by BOD from point-source discharges (0-5.6, 5.7-30, >31). Taxa number was highest within 26-50% native forest catchment and high BOD (>31) (mean =17), and lowest within high native forest catchment (76-100%) (mean=9) and low BOD (0-5.6%) (mean=12).

Periphyton ordination

The periphyton ordination plot (Fig. 8) also grades sites along Axis 1, from sites with clean water on the left, to sites with nutrient enriched waters on the right. This is supported by the high positive loadings for *Gomphonema, Synedra and Oedogonium* taxa on Axis 1. These algae are generally abundant within organically enriched stream environments. Axis 1 was also positively correlated to number of taxa and chlorophyll a. The MCI and SQMCI were negatively correlated with Axis 1, indicating the preference of "sensitive" clean water species (i.e., stoneflies and mayflies) to headwater streams with limited algal growth. Chlorophyll a correlated negatively to altitude and the percentage of catchment in native forest, whilst the

number of taxa correlated negatively to altitude and positively to stream width. Axis 1 explained 25% of the total variation whilst axis 2 explained 10%.

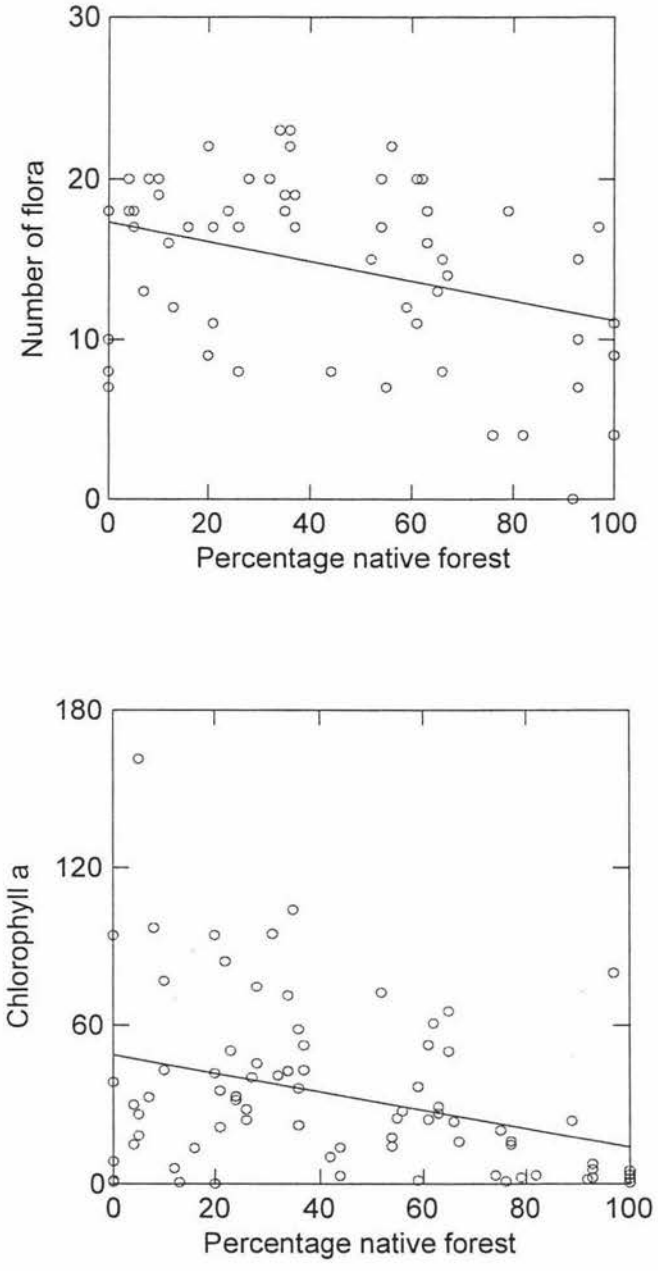
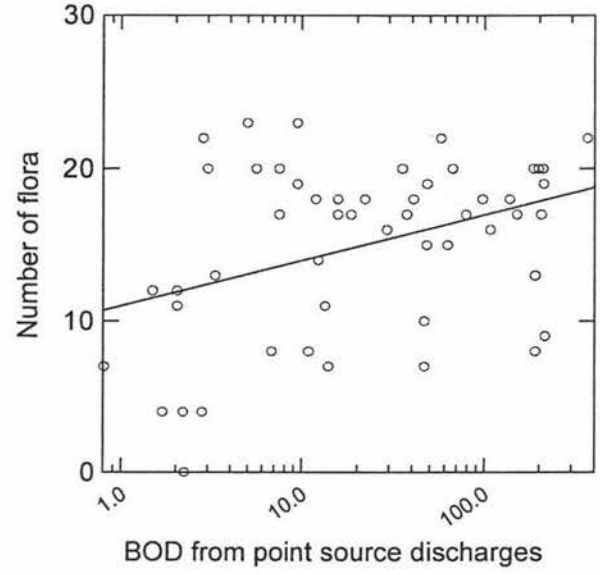


Figure 6 a) Number of flora and b) Chlorophyll a versus the percentage native forest (regression equation number of flora = 17.33 + .-062 (20) R^2 = 0.12, Chlorophyll a = 48.76 + -.35 (20) R^2 = 0.12, for macroinvertebrate samples collected from 83 sites on the Ring Plain between February and May 1998.



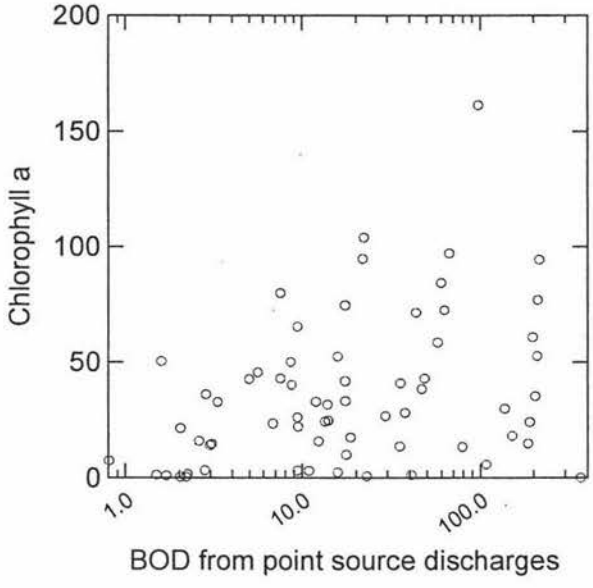


Figure 7 a) Number of flora and b) Chlophyll a versus BOD (regression equation number of flora = 11.77 + 2.54 (20) $R^2 = 0.14$, chlorophyll a = 18.03 + 14.73 (20) $R^2 = 0.13$), for macroinvertebrate samples collected from 83 sites on the Taranaki Ring Plain between February and May 1998.

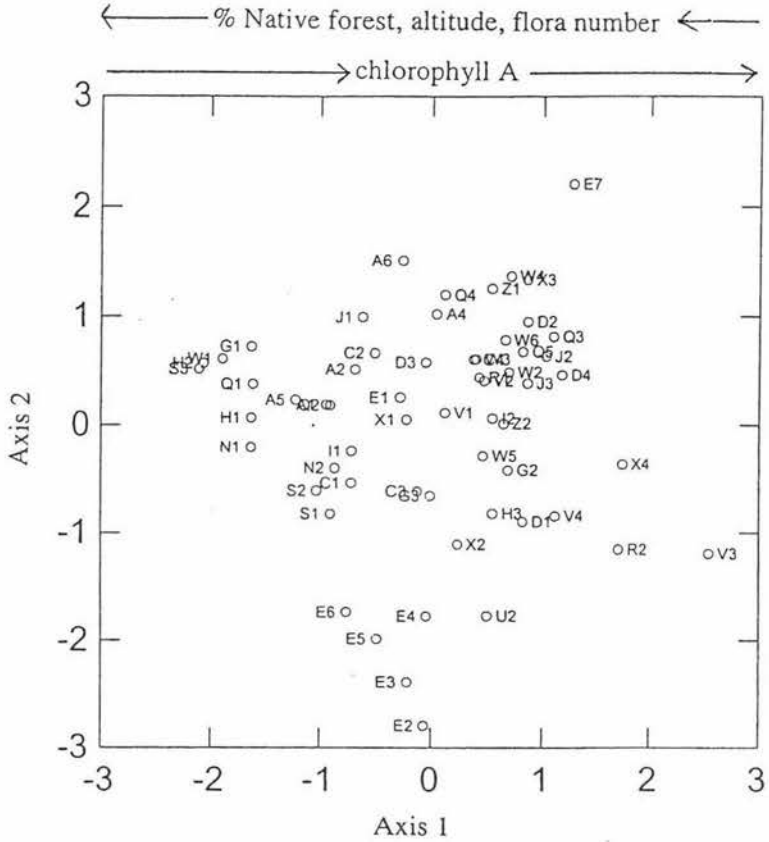


Figure 8 Periphyton ordination along the two main SYSTAT axes of the 83 sites surveyed on the Ring Plain, measured between February and May 1998. Chemical and environmental variables, which significantly correlate with these axes, are shown.

DISCUSSION

The effect of catchment land use on macroinvertebrate communities

A longitudinal gradient exists from sites with clean water species dominated by stoneflies, mayflies and caddisflies through to sites with enrichment tolerant species dominated by caddisflies, molluscs and Diptera as you move downstream on streams in the Taranaki Ring Plain. This change corresponds to a series of progressively more modified systems ranging from pristine, high altitude forested headwater streams, through to highly modified low altitude pastoral streams draining intensive farming and industrial catchments. This is consistent with Quinn et al. (1997) who noted that Waikato streams surrounded by pasture were dominated by chironomids, snails and worms which are tolerant to nutrient enrichment, whilst the "sensitive" mayfly and stonefly taxa that were common in forest streams were rare or absent. A change toward a more enrichment tolerant fauna at the pasture sites was also reflected in significantly lower taxa richness, MCI, SQMCI and percent EPT values. Quinn et al. (1997) also found lower EPT and QMCI values in pasture reaches of Waikato streams, indicating enriched stream conditions.

The structure of macroinvertebrate communities on the Ring Plain changes longitudinally in relation to downstream increases in sediment and nutrient runoff from agricultural land, together with organic enrichment from a large number of point source discharges to water from farm waste treatment systems (Taranaki Regional Council 1995c). The intensification of agricultural activities has led to an increase in BOD, conductivity and turbidity in streams in a downstream direction on the Ring Plain. Conductivity also has the tendency to increase progressively downstream due to more mineralised additions to the stream catchments during passage across the drained volcanic Ring Plain. Collier et al. (1997) also found a significant correlation between conductivity and the proportion of upstream catchment in pasture and Franklyn (1997) found increasing dominance of slow water or pollution tolerant taxa such as Diptera, as conductivity increased. Turbidity was also lower in the high altitude streams within forested catchments where native trees act to stabilise stream

banks. Trampling and erosion of stream banks by livestock may have also contributed to increased turbidity in pastoral Ring Plain streams effected by intensive dairy farming. Harding and Winterbourn (1995) note that disturbance by livestock may reduce water clarity, and increase sediment deposition and substrate instability. However turbidity did not correlate with macroinvertebrate communities within the ordination. Quinn and Hickey (1990b, 1997) also found increases in turbidity were generally within the tolerances of most invertebrates. Ring Plain sites with poor community richness were restricted to only a few stream catchments that contained naturally fine substrates in their underlying geology. Quinn and Hickey (1990b) and Jowett et al. (1991) found that fine substrates were unsuitable for many aquatic insect species. Subsequently, the number of taxa in habitats with substrates composed of small particle sizes is typically less than that found in substrates with larger and more heterogeneous particles (Pennak and Van Gerpen 1947; Allan 1975; Ward 1975).

Stream water temperatures were lower in the upper stream catchments which were shaded by the Egmont National Park, and the more developed riparian vegetation. In the warmer lowland pastoral sites on the Ring Plain, where a loss of riparian vegetation has occurred, there is an absence of Plecoptera and a decline in the number of Ephemeroptera taxa, which is consistent with the findings of Whitney (1939) and Nebeker and Lemke (1968) who have shown relatively low lethal temperature tolerances (around 20°C) for some species of Plecoptera and Ephemeroptera.

The remnants of once extensive native forest can only be found on the upper Ring Plain within the Egmont National Park, as most of the native forest has been cleared for agriculture. However altitude was more closely associated with axis 1 of the ordination than the percent of catchment in native forest, indicating that factors other than those relating to land use, may have also influenced the longitudinal pattern of macroinvertebrate communities on the Ring Plain. For instance, upper Ring Plain habitats have steeper gradients and faster stream flows, resulting in higher dissolved oxygen levels which allow a wider range of species to survive (Taranaki Regional Council 1995c). Zamora-Munoz and Alba-Tercedor (1996) also found that altitude correlated with the distributional pattern of invertebrate communities within

Spanish rivers, resulting in the presence of Diptera and Tubificidae in the lower catchments, the most tolerant species to organic pollution.

In summary, catchment land use and point source discharges from agricultural land were the major factors causing the longitudinal change in structure of macroinvertebrate communities in streams of the Taranaki Ring Plain, New Zealand. This was mostly attributed to the downstream increase in sediment and nutrient runoff and the loss of riparian vegetation from developed pasture, in conjunction with point source discharges from farm waste treatment systems. Macroinvertebrate taxa formed a gradient from "clean" water species such as mayflies, stoneflies and caddisflies within the unimpacted, forested headwater streams, to nutrient tolerant species such as caddisflies, Diptera and molluscs within the highly developed, pastoral lowland streams.

The effect of catchment land use on periphyton communities

There is a shift in periphyton communities over gradients of altitude on the Taranaki Ring Plain. The unimpacted, high altitude forested streams contain a low abundance of species, while low altitude streams draining intensive farming and industrial catchments have high abundances of *Gomphonema, Synedra* and *Oedogonium* spp, characteristic of streams with elevated nutrient levels and seasonal increases in temperature. The change in species abundance over catchment land use also corresponds to a shift from species poor communities in the forested headwaters through to species rich communities in the pastoral lowlands. This is consistent with the Otago Regional Council (1998) who found that some of the richest algal communities, particularly in the lowland reaches of east-coast rivers, were at sites with relatively high nutrient levels.

Although unicellular diatoms dominated the communities in relation to number of taxa, it was the multicellular green algae and filamentous diatoms that dominated in terms of biomass. The dominance of filamentous taxa within periphyton communities also appears to be a common feature of New Zealand's gravel-bed rivers in late summer (Biggs and Price, 1987). Biggs (1990) identified

dominant periphyton community types in a range of New Zealand river environments and also found that *Oedogonium* spp. and *Melosira* dominated the Taranaki region. *Cladophora* is common in many nutrient enriched New Zealand rivers (Biggs and Close 1989), and was also well represented within many of the lowland pastoral Ring Plain sites within intensive agriculture.

Algal biomass and taxonomic richness of periphyton communities was highest at sites with high levels of BOD accumulation from point source discharges. These sites were generally within open lowland pastoral sites, because in most Ring Plain catchments there is a progressive downstream increase in BOD from multiple dairyshed discharges, and industrial or municipal waste discharges. Quinn and McFarlane (1989) found that under conditions of very low BOD, the nuisance algal biomass is never likely to develop, however under conditions of abundant BOD, nuisance biomass were expected each summer.

Not surprisingly, changes in land use have a strong influence on sunlight exposure of streams (Quinn et al. 1997). Periphyton biomass (chlorophyll a) increased downstream in relation to water temperature, which was higher in the open, pastoral lowland sites which have a less developed riparian margin. It is generally recognised that temperature sets the upper limit for growth rates in algae, because the rate of many metabolic processes are highly dependent on temperature (DeNicola 1996). Generally, if nutrients are sufficient, then growth rates will be much higher with higher temperatures. For instance, respiration rates have been shown to double in some periphyton communities with a 10 °C increase in water temperature (Biggs 1998).

In summary, the intensification of agriculture has caused longitudinal changes in periphyton communities in a downstream direction on the Ring Plain, New Zealand. Periphyton communities formed a gradient from pristine headwater streams containing algal species of low biomass, through to lowland streams consisting of species indicative of enriched pastoral streams with a high amount of biomass. These patterns corresponded to an increase in BOD from point source discharges, and an increase in water temperature due to the loss of riparian margin, in a downstream direction on the Ring Plain.

CHAPTER 2 : COMPARISONS OF MACROINVERTEBRATE COMMUNITIES ON THE TARANAKI RING PLAIN.

Abstract. 1. Macroinvertebrate communities of 58 sites on streams of the Taranaki Ring Plain were sampled between February 1998 and May 1998, and compared to previous surveys by the Taranaki Catchment Commission (1982, 1984), Stark (1982) and Hirsch (1958).

2. Ordination of Ring Plain sites, indicate that a shift to more enrichment tolerant macroinvertebrate communities has occurred in many Ring Plain Streams.

3. Wilcoxon tests indicated that biotic indices (MCI, %EPT), number of taxa and percentage of taxa within each group (Plecoptera, Trichoptera, and Oligochaeta) were significantly different between 1980 and my study. In most cases, this was unrelated to the percentage of native forest or altitude at these study sites. Changes in benthic communities were mostly attributed to the intensification of land use, as well as point source discharges, changes in the flow regime and sand movement.

4. MCI values in this study have generally declined since Hirsch's survey, however my sites showed some recovery from dairy factory and septic tank discharges. This was indicated through smaller declines in MCI values between sites directly above and below discharge points in my survey.

Keywords. Freshwater macroinvertebrates; water quality, land use effects; point source discharges, New Zealand.

INTRODUCTION

There are few streams anywhere that have not been changed by drainage activities of farming, grazing of livestock, logging and urbanisation, or some combination of these (Moyle 1994). New Zealand streams are no exception, where agriculture and forestry are perceived to be the main causes of degradation to inland waters. Since human colonisation of New Zealand, two thirds of the almost complete forest cover has been removed, with about half this occurring in the last 150 years since European

colonisation (Pullar and McLeod 1992). As a consequence, human alteration has caused widespread degradation of aquatic ecosystems (Naiman et al. 1995).

An interest in the effects of water quality on the bottom-dwelling invertebrate fauna of streams and rivers, has existed since the pioneering work of Hirsch (1958). Suckling (1982) and Boon (1992) found that changes in water quality often lead to changes in the composition of the biotic community inhabiting a river, usually with a decrease in the biological diversity of the aquatic ecosystem. However, there are still very few studies investigating long-term changes in benthic stream communities (Likens 1983). In one of the few studies, Townsend, Hildrew and Schofield (1987) compared invertebrate communities from surveys in 1976 and 1984 in southern England. This indicated that persistence was greatest at low discharge, upstream sites with cool temperature regimes and low, stable pH. Weatherley and Ormerod (1990) examined the constancy of invertebrate communities sampled annually for 5 years in Britain. They found variations in the invertebrate communities across streams in persistence from year to year, and some evidence of long-term changes. However the data encompassed too few years for causal factors to be identified.

Most long-term studies have focused on the effects of disturbance on macroinvertebrate communities. These have related to pulse events including pollutants such as pesticides (Hutchens et al. 1998), insecticides (Whiles and Wallace 1995) and flood events (Giller, Sangpradub and Twomey 1991), as well as press events such as clear felling (Campbell and Doeg 1989; Stone and Wallace 1998), mining (Hoiland, Rabe and Biggam 1994), wildfire (Richards and Minshall 1992) and channelisation (Arner et al. 1976).

Although macroinvertebrate communities are highly effective indicators of water quality, limited research has been undertaken to investigate changes in macroinvertebrate community structure over time. Taranaki Ring Plain streams have been studied extensively in the past, and this provided the opportunity to examine macroinvertebrate communities over more than a decade in time. In this study, I investigate whether any significant changes in water quality have occurred on the Taranaki Ring Plain since previous surveys by Stark (1982), The Taranaki Catchment Commission (1982, 1984) and Hirsch (1958). This involved identifying changes in

the structure of macroinvertebrate communities between surveys based on the differential sensitivities of taxa to environmental and chemical variables.

STUDY AREA

Forty-nine sites scattered on the Taranaki Ring Plain, were chosen from the 83 sites sampled in chapter 1 and compared to data from the early 1980's (Table 1, Figure 1). This includes 42 of the sites from the Taranaki Ring Plain Report (Taranaki Catchment Commission, 1984), 5 sites in the Patea River (Stark, 1982), and 2 sites in the Kapuni Stream (Taranaki Catchment Commission 1982). Twelve of the sites from the 83 sites sampled in chapter 1 were also selected and compared to data from Hirsch's survey (1958), (Table 2, Figure 1).

Table 1 Location of the 49 Ring Plain sites which were surveyed between February and May 1998, and compared to previous studies in the 1980's.

River/Stream	Location	Site No.
Inaha S.	3.5km d/s Eltham Rd	A3
	Normanby Rd bridge	A4
	SH45	A5
Kahouri S.	2km u/s of SH3	C1
	SH3 bridge	C2
	D/s Flint Rd bridge	C3
	20m u/s of Piakau S. Confluence	C4
Kapoaiaia S.	Wiremu Rd, 30m u/s of bridge	D1
	Immed. U/s Pungarehu Dairy Factory	D2
	SH45a below Pungarehu Dairy Factory	D4
Kaupokonui R.	Opunake Rd	E1
	1km d/s Kaponga ox. Pond discharge	E4
	Upper Glenn Rd	E6
Kapuni S.	Opunake Rd	F1
	Skeet Rd	F3
Manganui R.	3km u/s SH3	G1
	400m u/s Tariki Rd	G2
	300m d/s Tariki Power Diversion Weir	G3
Mangahume S.	Wiremu Rd bridge	H1
	Eltham Rd	H2
	SH45 bridge	H3
Mangaoraka S.	2km u/s Kaimiro	J1

	Opp. Union Rd	J2
	Devon Rd (SH3)	J3
Timaru S.	Carrington Rd	N1
	SH45, 100m u/s of bridge	N2
Patea R.	Barclay Rd bridge	Q1
	Cardiff Rd bridge	Q2
	Brecon Rd	Q3
	500m u/s of Kahouri S. Confluence	Q4
	Skinner Rd bridge	Q5
Punehu S.	Opunake Rd	R1
	500m d/s Mangapapa S. Confluence	R2
Stony S.	Near end of Saunders Rd	S1
	Wiremu Rd	S2
	SH45	S3
Waiongana S.	Adj. Egmont Rd	V1
	2km u/s SH3	V2
	SH3A bridge	V3
	Manutahi Rd	V4
Waingongoro R.	Opunake Rd	W1
	End of Clifford Rd	W2
	350m d/s Riverlands discharge	W3
	300m u/s Mawhitiwhiti Rd	W5
Waiwakaiho R.	Alfred Rd Track	X1
	700m u/s Confl. of Kaiauai S.	X2
	Burgess Park	X3
	60m u/s rimu St landfill	X4
Waitara R.	Bertrand Rd	Z1
	U/s Waitara Landfill	Z2

Table 2 Location of the 12 Ring Plain sites which were surveyed between February and May 1998, and compared to Hirsch's survey in 1958.

River/Stream	Location	Site No.
Inaha S.	SH45	A5
	150m d/s SH45	A6
Kapoaiaia S.	Immed. u/s Pungarehu Dairy Factory	D2
	100m u/s SH45	D3
	SH45a below Pungarehu Dairy Factory	D4
Kaupokonui R.	250m u/s Kaponga ox. pond discharge	E2
	50m d/s Kaponga ox. Pond outfall	E3
	Skeet Rd bridge	E5
	Upper Glenn Rd	E6
	SH45	E7

Otakeho S.	Skeet Rd	P2
	50m d/s Skeet Rd	P3

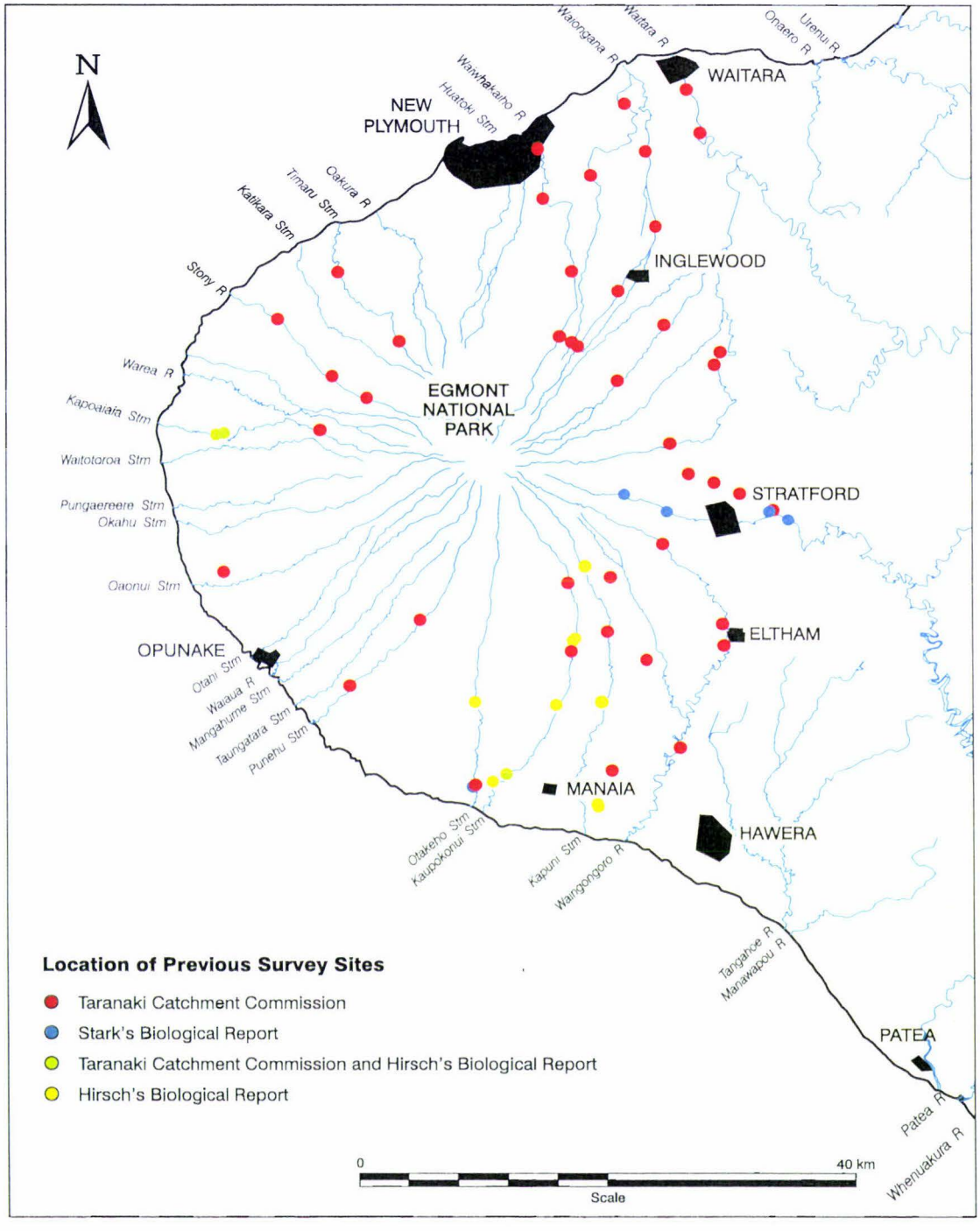


Figure 1 Location of 58 Ring Plain sites surveyed between February and May 1998 and within previous surveys (Taranaki Catchment Commision 1982, 1984; Stark 1982; Hirsch 1958).

MATERIALS AND METHODS

Methods for the collection of environmental variables and macroinvertebrate samples for my study are reported in chapter one.

Environmental variables

The Ring Plain Report (1984)

The Taranaki Catchment Commission conducted sampling in January and February 1982. Water temperature was recorded with a mercury thermometer where sampling took place. Substrate particle size was measured with a quadrat one square metre in area, which was placed at random in the streambed of each survey site. Substrate particles were grouped into 15 size categories based on Wentworth (1922). I regrouped these into 6 size categories as in chapter 1, and converted them into a single index following Jowett et al. (1991) to allow consistency between data sets. A 1L water sample was collected from each site in a clear, screw-top, plastic container for the determination of pH and water turbidity. pH measurements were made using a portable pH meter (TRIAC – DPH 1), accurate to 0.1 units. Turbidity was measured using a turbidimeter (HACH Model 2100A) with calibration in nephlometric turbidity units (NTU) with ± 0.1 accuracy.

Point source discharges to water within 1 or 2 km upstream of each site were quantified from resource consents as indicated in chapter 1. However, only consents that were active in 1998 and inactive in the early 1980's were examined. Flow graphs were examined for each site in my survey and studies in the 1980's, in order to detect the number of days since a previous significant fresh (above historical median flow).

Hirsch's study (1958)

Sampling was conducted in November 1956 and March 1957. This did not include any chemical or environmental analysis.

Invertebrate sampling

The Ring Plain Report (1984)

Samples were collected in a 0.5mm mesh kick net for roughly 10 seconds. To maintain consistency between studies a number of taxa were combined. Nematodes and *Eiseniella* were combined with Oligochaetes in my study, as these were previously combined in the 1984 study. Species were grouped into genera in the 1984 study, so that they could be compared with invertebrates in my study. As Empididae pupae were probably misidentified as Ceratopogonidae in the 1984 study, they were combined in both the 1984 and 1998 data sets. All animals were counted in 1984, however these have been categorised in accordance with the methods in Chapter 1, to provide consistency between data sets (Table 2, appendix).

Hirsch's survey (1958)

Hirsch's samples were collected with a fine-meshed dip net. Length of sample time and volume of material collected were unspecified, although it is likely that a sample collection was rapid. Only invertebrates visible to the naked eye were sorted and identified (Hirsch, 1958). As a consequence, small taxa such as Acarina were most likely overlooked. Misidentifications may have also taken place. For example Nemertea were not recorded but were probably identified as Oligocheatea. Hirsch also used a finer taxonomic resolution than in my study. Organisms from the Otakeho Stream, Inaha Stream and Kapoaiaia Stream were grouped into the following categories: scarce (S), common (C), abundant (A), and very abundant (V). However Hirsch decided that these groups were too wide and that information was being lost, and so organisms collected from the Kaupokonui Stream were grouped as follows: 1 organism (a), 2-3 (b), 4-6 (c), 7-12 (d), 13-24 (e), 25-49 (f), 50-99 (g), 100-199 (h), 200-399 (i), 400 and over (j). I regrouped these in accordance with the methods in Chapter 1.

Statistical Methods

To investigate trends across sites, Principle Components ordination was performed between my sites and sites from previous surveys by the Taranaki Catchment Commission (1982, 1984), Stark (1982) and Hirsch (1958), using SYSTAT (1998). Pearson correlations with Bonferroni adjustments were conducted between the environmental and chemical variables and the first axes. The differences between my sites and early 1980's survey sites based on biological indices (MCI, Margarlef's Index, Simpson's Index), the number of taxa and percentage of taxa within each family, was analysed using non-parametric Wilcoxon Tests. This involves using the rank order of the differences between a variable of two samples, to determine whether or not they are equal. Regression analysis was performed to reveal whether differences in macroinvertebrate communities (through biotic indices (MCI, SQMCI, % EPT, Margarlef Index, Percentage Similarity), number of taxa and percentage taxa in each family) between my survey and 1980's surveys, were related to the proportion of catchment in native forest or altitude. An ANOVA was used to examine if differences in biological indices (MCI, SQMCI, %EPT), number of taxa and the percentage taxa in each family, were significant between my study and 1980's studies, over sites grouped in relation to the percentage of catchment in native forest (0-25, 26-50, 51-75, 76-100). All were performed with SYSTAT (1998).

RESULTS

Comparison between my study and 1980's studies

Macroinvertebrate community composition

Wilcoxon tests indicated that biological indices (MCI: Z=2.58, P=0.01, SQMCI: Z=2.25, P=0.05 and percentage EPT: Z=4.5, P=0.000) were higher in the 1980's studies, whereas the number of taxa (Z=3.25, P=0.001) was greater in my study. However differences in biological indices and number of taxa between these studies, was not related to percentage of catchment in native forest or altitude (MCI: $F_{1,47}$=0.10, P>0.05 and F $F_{1,47}$=0.92, P>0.05, respectively; SQMCI: F=0.18, P>0.05 and $F_{1,47}$=0.62, P>0.05, respectively; percentage EPT: $F_{1,47}$=1.07, P>0.05 and $F_{1,47}$=2.42, P>0.05, respectively; taxa number: $F_{1,47}$=1.36, P>0.05 and $F_{1,47}$=0.44, P>0.05, respectively) (Fig 2 and 3). Diversity indices were similar across surveys (Margarlef's Index: Z=-1.37, P>0.05, respectively, Simpson's Index: Z=1.65, P>0.05, respectively), and differences did not correlate with catchment in native forest or altitude (Margarlef's Index: F=2.11, P>0.05 and $F_{1,47}$=2.79, P>0.05, respectively; Simpson's Index: $F_{1,47}$=0.16, P>0.05 and $F_{1,47}$=0.70, P>0.05, respectively).

The percentage of mayfly (Z=1.09, P>0.05), dipteran (Z=-0.85, P>0.05), and molluscan taxa (Z=-0.33, P>0.05) were also similar between my study and 1980's studies. However there were significantly more stonefly (Z=-3.50, P=0.000) and oligochaete taxa (Z=-4.40, P=0.000) in my study, and more caddisfly taxa (Z=3.90, P=0.000) in the early 1980's studies. The differences in percentage of mayfly ($F_{1,47}$=2.24, P>0.05 and $F_{1,47}$=2.24, P>0.05, respectively), caddisfly ($F_{1,47}$=1.92, P>0.05 and F=2.42, P>0.05, respectively), and Diptera taxa ($F_{1,47}$=0.00, P>0.05 and $F_{1,47}$=0.00, P>0.05, respectively) within each family, were also unrelated to the proportion of catchment in native forest or altitude. However, the percentage difference for oligochaete ($F_{1,47}$=4.87, P=0.05) and mollusc taxa ($F_{1,47}$=13.12, P=0.001) between surveys correlated to altitude, and indicated that differences between surveys were greatest at lowland sites. The percentage difference in stonefly taxa between surveys correlated to altitude ($F_{1,47}$=20.51, P=0.000) and the proportion

of catchment in native forest ($F_{1,47}$=22.13, P=0.000), and indicated that differences were greatest at headwater sites. Percentage similarity between surveys ($F_{1,47}$=2.90, P>0.05 and $F_{1,47}$=0.14, P>0.05 respectively), did not relate to catchment in native forest or altitude.

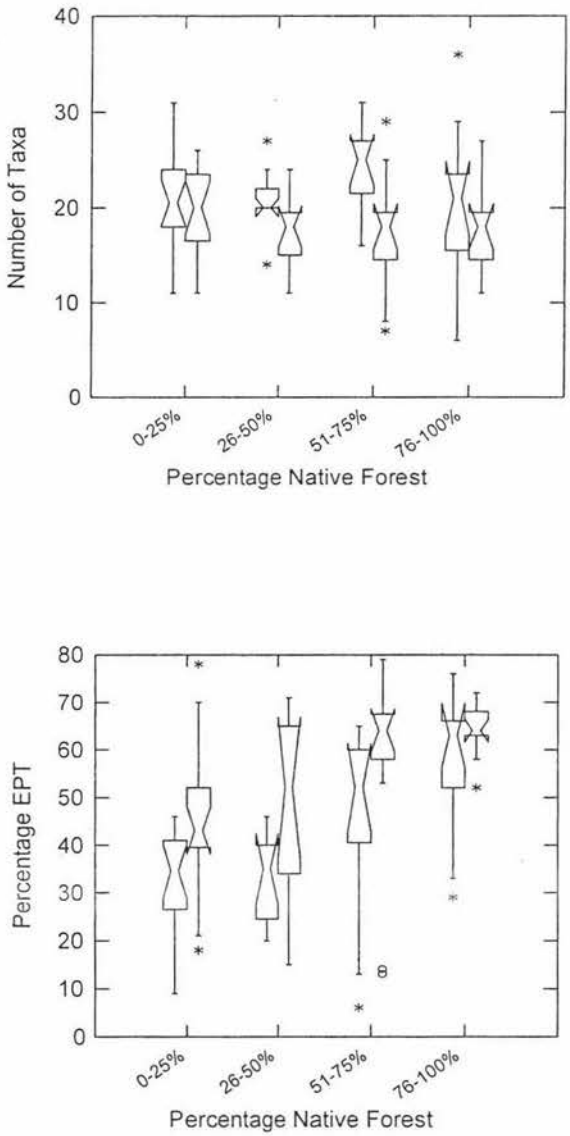
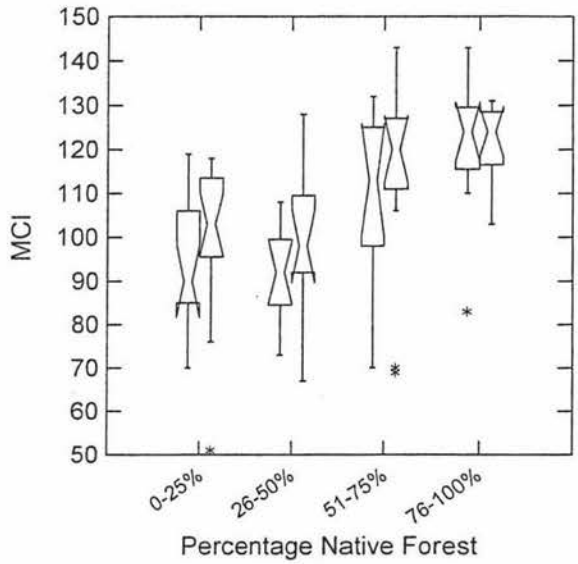


Figure 2 The number of taxa and percent EPT in relation to catchment in native forest at 49 sites in the Taranaki Ring Plain, sampled from February to May 1998 and January to February 1982. (The first boxplot within each landuse category has data from my study, whilst the second boxplot within each landuse category has data from 1980s studies).



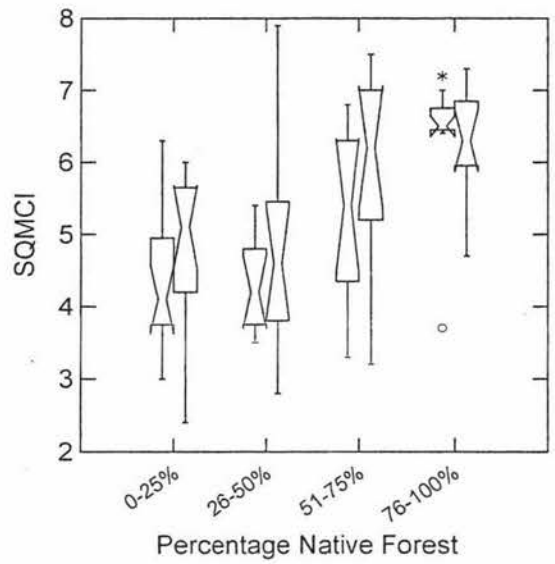


Figure 3 The MCI and SQMCI in relation to catchment in native forest at 49 sites in the Taranaki Ring Plain, sampled from February and May 1998 and January and February 1982. (The first boxplot within each landuse category has data from my study, whilst the second boxplot within each landuse category has data from 1980s studies).

Stark (1998) noted that in order for two samples to be regarded as significantly "different" from each other a change in MCI of at least 10.8 units is required, provided a similar single kick net sampling technique is used. The following Ring Plain sites in Table 3 indicate differences in MCI values of at least 10.8 units. Most sites with significant differences in MCI scores, also revealed major changes in the abundance of nutrient tolerant species between my study and 1980's studies. For instance, Oliogochaete and *Oxyethira* species were rare or absent in the 1980's studies, yet abundant in my study (Sites: D1, J1, J2, J3, N2, Q3, R2, V2, W2, W5, X3, X4).

Table 3 Sites sampled from February to May 1998 in the Taranaki Ring Plain indicated differences in MCI values of at least 10.8 units since previous surveys by the Taranaki Catchment Commission (1982, 1984) and Stark (1982). (Water quality improvement =+, decline =- in my study).

River/Stream	Location	Site No.	MCI
Kapoaiaia S.	Wiremu Rd, 30m u/s of Bridge	D1	-14
Kaupokonui R.	1km d/s Kaponga ox. Pond discharge	E4	-17
	Upper Glenn Rd	E6	-21
Kapuni S.	Opunake Rd	F1	+19
Mangaoraka S.	2km u/s Kaimiro	J1	-31
	Opp. Union Rd	J2	-22
	Devon Rd (SH3)	J3	-20
Timaru S.	Carrington Rd	N1	+14
	SH45, 100m u/s of Bridge	N2	-27
Patea R.	Brecon Rd	Q3	-20
Punehu S.	500m d/s Mangapapa S. Confluence	R2	-28
Stony R.	Wiremu Rd	S2	-21
Waiongana S.	2km u/s SH3	V2	-28
	Manutahi Rd	V4	+24
Waingongoro R.	End of Clifford Rd	W2	-31
	350m d/s Riverlands discharge	W3	-19
	300m u/s Mawhitiwhiti Rd	W5	-33
Waiwhakaiho R.	Burgess Park	X3	-14
	60m u/s rimu St landfill	X4	+14

Macroinvertebrate ordination and correlations with environmental factors

A similar trend to that obtained in Chapter 1 of this study was indicated in the macroinvertebrate ordination plot on Axis 1. This trend indicated (Figure 4) a gradient of sites across the plot, from lowland pastoral sites with taxa which are relatively enrichment tolerant on the left, through to forested headwater sites with taxa which prefer clean water on the right side of the plot.

High altitude, forested sites on the right side of the plot had high abundances of *Deleatidium* spp., *Beraeoptera,* and *Coloburiscus* taxa, whilst low altitude, pastoral sites on the left of the plot had high abundances of *Oxyethira,* Oligochaeta and Tanytarsini. Axis 1 was positively correlated with altitude, whilst negative relationships were indicated with temperature and pH. Biological indices (MCI, SQMCI, percentage EPT, Margarlef's Index) and the number of taxa, were positively correlated with Axis 1.

Sites generally changed in a leftward direction between my study and that of the 1980s, and vectors indicating change usually covered at least half of the horizontal axis. Those sites showing substantial change were scattered across the Taranaki Ring Plain, and indicated that a reduction in water quality had occurred since studies in the early 1980's. A majority of these sites also illustrated a decline in MCI values of at least 10.8 units since studies in the 1980's. Sites on the left side of the plot also changed in a leftward direction, however the magnitude of change was often a lot smaller than that found at the sites above. These sites were generally within lowland streams of the Ring Plain. Sites on the right side of the plot changed in a rightward direction, although the magnitude of change was also small. These sites were generally within headwater streams of the Ring Plain. As these sites changed in a rightward direction, it is possible that some of these sites have experienced an improvement in water quality since studies in the early 1980's. However changes in MCI values of at least 10.8 units has only occurred at headwater sites on the Kapuni and Timaru Streams. The randomisation test using Principle Components (SYSTAT, 1998), indicated that community structure has changed in a consistent manner (P=0.0001) since surveys in the 1980's.

Axis 2 was positively associated with macroinvertebrate community richness (Margarlef's Index, number of taxa), whilst negative associations were indicated with macroinvertebrate community evenness (Simpson's Index). Sites generally changed in an upward direction since surveys in the 1980's, indicating an increase in biodiversity in my study. The number of days after a fresh (historical median flow) in which samples were taken for 1980's studies and my study, was not a significant factor effecting these results. This ordination indicated that Axis 1 described 26% of the variation, whilst Axis 2 described 15%.

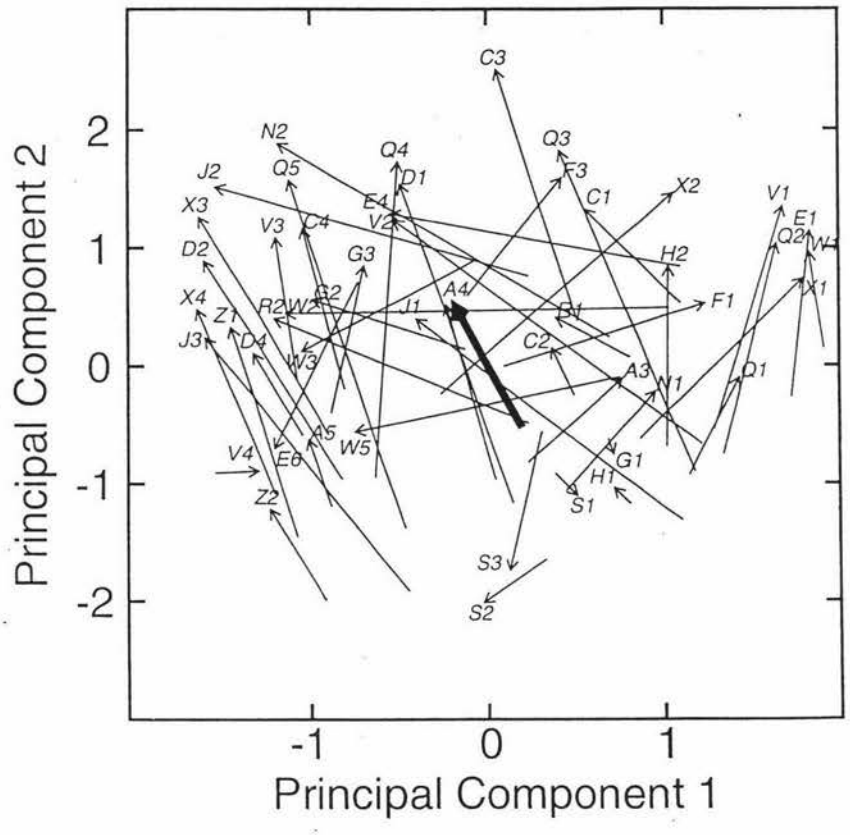


Figure 4 Ordination of macroinvertebrate samples collected from 49 sites on the Taranaki Ring Plain between February and May 1998 and January and February 1982. Vectors joining each pair of samples for each site, represent the magnitude and direction of change in community structure between these surveys.

Comparison between my study and Hirsch's study in 1958

Macroinvertebrate community composition

Biological indices were higher in Hirsch's survey (MCI: F=2.12, P=0.05, SQMCI: F=2.50, P=0.01) than in my study within a Wilcoxon test. However diversity indices (Margarlef Index:Z=-0.78, P>0.05, Simpson's Index: Z=1.65, P>0.05) and the number of taxa (Z=-1.74, P>0.05), were similar between studies. The percentage of caddisfly (Z=-0.32, P>0.05), stonefly (Z=-1.63, P>0.5), molluscan (Z=-1.51, P>0.05) and oliogocheate taxa (Z=0.39, P>0.05) were also similar across these surveys, however my study contained more dipteran (Z=-2.67, P=0.01) and less mayfly taxa (F=2.80, P=0.01) than Hirsch's study. Although dipteran taxa (excluding chironomids) were more abundant in my survey, the pollution tolerant chironomid taxa were absent from my sites, whilst five of Hirsch's sites contained these taxa. Many chironomid species inhabit septic stream conditions and are an indication of enriched conditions.

Table 4 indicates Ring Plain sites with significant (following Stark (1998) of 10.8 units) MCI differences between surveys, and illustrates differences in taxa number at these sites. Although MCI values are significantly higher at sites A5 and P3 in Hirsch's study, the number of taxa was lower at Hirsches sites (A5:8 taxa, P3:7 taxa) compared to my sites (A5:15 taxa, P3:17 taxa), therefore the presence of small numbers of sensitive scoring *Deleatidium* spp. at Hirsch's sites has caused the MCI score to raise considerably more than if there was a higher taxonomic richness. Although MCI values were similar between studies at the A6 site, taxonomic richness was also lower at Hirsch's site (5 taxa) compared to my site (16 taxa), and the *Chironomus* species which were absent at my site, were commonly found at Hirsch's site. However the rare occurrence of *Deleatidium* sps at Hirsch's site, also caused the MCI value to raise disproportionately. The remaining sites in Table 4 that indicate significant differences in MCI values, reveal major changes in invertebrate species between surveys. For instance, the enrichment tolerant *Oxyethira* species was abundant or common at many of my sites and absent from Hirsch's sites (P2, D2, D3, D4, E6), whereas the clean water *Deleatidium* spp. was absent from many of my sites and abundant at Hirsch's sites (P2, D2, D4, E6).

Table 4 Sites sampled from February to May 1998 in the Taranaki Ring Plain indicated differences in MCI values of at least 10.8 units since Hirsch's survey (1958). (Water quality improvement =+ or decline =- in my study).

River/Stream	Location	Site No.	MCI	Taxa No.
Inaha S.	SH45 (Taranaki By-products)	A5	-17	7
Kapoaiaia S.	Immed. u/s Pungarehu Dairy Factory	D2	-41	10
	100m u/s SH45 (D/s Pungarehu D/f)	D3	-26	4
	SH45a below Pungarehu Dairy Factory	D4	-39	1
Kaupokonui S.	Skeet Rd Bridge	E5	+56	9
	Upper Glenn Rd	E6	-15	-4
Otakeho S.	Skeet Rd	P2	-23	2
	50m d/s Skeet Rd	P3	-11	10

Negative differences between MCI scores immediately upstream and downstream from each other within each survey were significantly higher at Hirsch's sites than my sites (Table 5). This was due to the effects of dairy factory and septic tank point source discharges, which have been eliminated since Hirsch's survey. The greatest difference in MCI values occurred at Hirsch's sites immediately above and below the lactose factory on the Kaupokonui River (89 MCI units), and also 3 miles downstream (39 MCI units).

Table 5 Longitudinal differences in MCI scores between upstream and downstream sites in my study sampled between February and May 1998 and Hirsch's study sampled in 1958, at 12 sites in the Taranaki Ring Plain.

River/Stream	Upstream location	Downstream location	Site No.	Difference in MCI between up and downstream	
				(1998)	(1958)
Otakeho S.	U/s Auroa dairy factory	Immed. d/s Auroa d/f	P3	1	11
Kapoaiaia S.	U/s Pungarehu d/f	Immed. d/s Pungarehu d/f	D3	4	19
	Immed. d/s Pungarehu d/f	100 m d/s Pungarehu d/f	D4	4	17
Inaha S.	U/s Mania d/f	Immed. d/s Mania d/f	A5?	3	12
Kaupokonui S.	Immed. D/s Kaponga d/f	200 m d/s Kaponga d/f	E3	5	4
	200 m d/s Kaponga d/f	Immed. d/s Lactose fact.	E5	28	89
	Immed. D/s Lactose fact.	8 km d/s Lactose fact.	E6	2	39
	U/s Mania D/f	Immed. d/s Mania d/f	E7	3	11

Macroinvertebrate ordination and correlations with environmental factors

A trend similar to that obtained in Chapter 1 of this study was also indicated in the invertebrate plot on Axis 1. This trend indicated (Fig 5) a gradient of sites across the plot, from forested headwater sites with enrichment sensitive taxa on the left, through to low pastoral sites with taxa which are enrichment tolerant on the right side of the plot. High altitude sites on the left of the plot had high abundances of *Nesmeletus*, *Deleatidium* spp. and *Olinga* species, whereas low altitude sites on the right of the plot had high abundances of *Oxyethira, Austrosimulium* and other Dipteran species. Axis 1 was positively correlated with the SQMCI. All sites changed consistently in a rightward direction since Hirsch's survey, indicating the strong possibility of water quality deterioration.

Sites on the right of the plot on Axis 2 had high abundances of Diptera, *Archichauliodes* and *Aoteapsyche* species whereas sites on the left of the plot had high abundances of *Potamopyrgus,* Oligochaeta, and *Hirudinea* species. Axis 2 was positively correlated with MCI and percentage EPT. Sites generally changed in a rightward direction since Hirsch's survey, which also suggests a decline in water quality.

The randomisation test using Principle Components (SYSTAT, 1998), revealed that community structure had changed in a consistent manner (P=0.0005) since Hirsch's survey. Axis 1 of the ordination described 31% of the variation, whilst Axis 2 explained 14%.

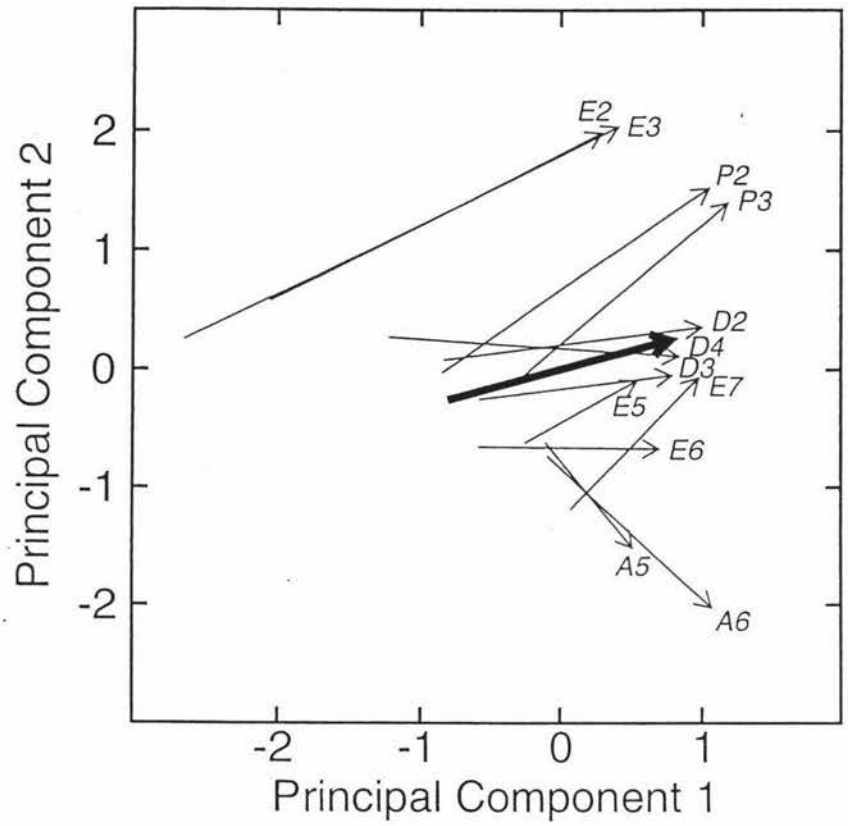


Figure 5 Ordination of Macroinvertebrate samples collected from 12 sites on the Taranaki Ring Plain between February and May 1998 and June and July 1958. Vectors joining each pair of samples for each site, represent the magnitude and direction of change in community structure between these surveys.

DISCUSSION

In general MCI, SQMCI and %EPT (in 1982 only) values in Ring Plain streams decreased in my study from those in 1982 and 1958. The decrease in biotic indices in my study was a result of a change to more enrichment tolerant macroinvertebrate taxa. This involved an increase in abundance of *Oxyethira,* Oligochaeta, and *Tanytarsini* species and a decrease of *Deleatidium* sp., *Beraeoptera* and *Coloburiscus*. Previous studies (Hynes 1960; Scott 1973; Winterbourn 1981; Penny 1985; Stark 1985b; Scott 1989), have also noted shifts from stoneflies, mayflies and caddisflies, to communities characterised by Molluscs, Diptera and Oligochaeta, associated with increased organic pollution. Most of my sites where this occurred, also had differences in MCI values of at least 10.8 units, between mine and latter surveys (Stark 1998).

The change in structure of macroinvertebrate communities between Ring Plain surveys is most likely a result of intensification of landuse practices. Sediment and nutrient runoff from agricultural land, together with a large number of point source discharges from farm waste treatment systems, combine to put pressure on water resources, particularly in the middle and lower catchment areas of the Ring Plain where dairying is most intense (Taranaki Regional Council 1995c). Taranaki is also characterised by highly fertile and free draining soils, which, with the application of fertilisers, can provide opportunities for increasingly intensive dairy farming practices (Taranaki Regional Council 1995b). This has resulted in a steady increase in the number of dairy cattle in Taranaki, with a 16% increase since 1975 (Taranaki Regional Council 1995c).

It was hypothesised that declines in MCI values would be larger at lowland sites due to the higher percentage of upstream catchment in pasture, and the smoother gradient suitable for higher stocking rates. However a reduction in water quality occurred over a range of sites scattered across the Ring Plain, and was not related to altitude or the percentage of catchment in native forest. It may be that some of these lower catchment sites have already reached their maximum sustainable carrying capacity for cows. There is also the possibility that the localised degradation of water

quality in some of the catchments is due to the types of waste treatment systems in place, the location of stock access, and unauthorised discharges or spills.

The impacts of land-use activities on streams is an issue world-wide (Naiman et al. 1989, 1995; Bunn 1993). 'Modern' agriculture with its reliance on pesticides and artificial fertilisers, has intensified the effects of farming upon many streams (Dance and Hynes 1980). As a result, river ecosystems are being increasingly threatened (Benke 1990; Boon 1992; Allan and Fleker 1993). In Danish agriculture, the use of nitrogen in commercial fertiliser has increased by 450% since the mid 1950's, in conjunction with the intensification of livestock production. Schofield et al. (1990) found a significant deterioration in the quality of many streams accompanied by high densities of a few pollutant-tolerant species such as Chironomids draining directly from farmyards and areas of intensive landuse in the Eastern Cleddau Catchment. This was accompanied by a poor biological status, with high densities of only a few pollutant-tolerant species such as Chironomids.

The impacts of land use on the health of New Zealand waters has been described by the Minister for the Environment as the most significant environmental issue facing the nation (Upton 1994). Agriculture has been shown to affect many of the characteristics of New Zealand's stream, including their invertebrates (Quinn and Hickey 1990b; Harding and Winterbourn 1995; Townsend et al. 1997). Scott et al (1994) in a study of changing from extensive to intensive grazing in Southland, New Zealand, found a decrease of clean water species and an increase in enrichment tolerant species.

Point source discharges, water abstraction and sand movement

The dairy processing industry was recognised as having the greatest localised impacts on freshwater quality of all point source discharges in Taranaki. Amalgamation and rationilisation in the dairy industry over the past 20 years however, has caused a dramatic reduction in the number of dairy process factories and associated discharges to surface waters (Taranaki Regional Council 1995c). McColl (1982) reported a 75% reduction on total point source BOD loadings to freshwater between 1971 and 1981

in New Zealand, largely as a result of dairy factory closures. This is consistent with my findings which reveal significant recovery from dairy factory point source discharges since Hirsch's survey, although further recovery is possible. The decline in MCI values directly above and below discharge points were smaller in my survey compared to those in the 1958 survey. This is also supported by the presence of Chironomid species (which are indicative of severe pollution and probably septic or near septic conditions (Hirsch 1958)) downstream of discharges in Hirsch's study but not mine.

The highest negative difference in MCI values occurred between sites upstream and downstream of the Lactose factory on the Kaupokonui Stream in Hirsch's study. Hirsch (1958) indicated that these wastes exerted a demand exceeding the self-purification capacity of the stream over a distance of some miles, while the other sources had little effect. Although the difference in MCI values between surveys has declined, it is possible that the Lactose factory is continuing to exert an influence on macroinvertebrate communities below this discharge point. The Taranaki Regional Council (1995a) indicates that impacts from the waste disposal activities at the Lactose Company farm and factory have caused MCI values to frequently fall below 75 units at this site. My sites which were previously downstream from dairy factories on the Otakeho Stream, Kapoaiaia Stream and the Inaha Stream however, appear to have recovered, MCI values directly upstream and downstream of these discharge points are similar. This is due to the closure of these dairy factories since 1958. However my site, which is approximately 8 kilometres downstream from the Lactose factory (E6), indicated a reduction in water quality since studies in the 1980's. However, as my site directly below the dairy factory does not indicate a change in water quality, it is more likely that the reduction in water quality at E6 caused by the intensification of land use.

Discharges from the Riverlands Meatworks and Eltham wastewater treatment ponds may have caused changes in macroinvertebrate communities in the Waingongoro River since studies in the 1980's. There have been a few instances where pollution events (measured by falling MCI's) have also been recorded at these

sites during past monitoring by the TRC (1995a), all of which have been associated with Riverlands Meatworks.

A likely explanation for the improvement in water quality at the lowland site on the Waiwhakaiho River (X4) since studies in the 1980's, are the changes in flow regime made by the Powerco Mangorei Hydro Electric Power Scheme. These included a more regular flow, and an increase in residual flows. Temperatures of previous low flows would have become elevated in a downstream direction, causing greater algal growth and resulting in the disappearance of 'sensitive' invertebrates with distance downstream. The Taranaki Regional Council (1995a) also found an improvement in water quality at this site since studies in the 1980's indicated by increased taxonomic richness, MCI and SQMCI scores. However the increase in MCI values at this site in my study, contrasts with the ordination results of most sites which indicate a water quality decline. An improvement in water quality was found at the lowland site on the Waiongana River (V4), which may be due to a substantial reduction in the amount of water abstracted for the Waitara municipal and industrial water supply since studies in the 1980's.

Discharges from dairysheds are the most numerous point source discharges in Taranaki (Taranaki Regional Council 1995c). Dairy effluent discharges from treatment ponds that were active in my study and inactive in studies from 1982 were examined within 2 kilometres upstream of each site. A direct discharge was indicated at the lowland sites on the Waingongoro River (W5) and the Punehu Stream (R2), as well as a discharge 500m upstream of the middle site on the Mangaoraka Stream (J2) and lowland site on the Punehu Stream. Abatement notices including a sump overflow in 1996 have also been issued concerning the dairy effluent discharge approximately 500m upstream from the Punehu Stream site. However the effect of these treatment pond discharges on the benthic communities is unclear, because discharges from treatment ponds in Taranaki usually decrease or cease after the mid summer months.

Streambeds of the Taranaki Ring Plain are less stable than in many other parts of the country, and 'waves' of sand and sediment are known to move downstream in some waterways (Taranaki Regional Council 1995a). Suspended solids have the

ability to smother the river bed by settling, and to cause DO reductions in interstitial water and overlying river waters by respiration and decay (Ryan 1991), which can also lead to the loss of benthic communities. There have been fluctuations in MCI values over the years in the Kapuni Stream as a response to the infilling of substratum interstices by sand, due to slips on Mt Taranaki (Stark 1990). This may explain the decline in MCI values at the headwaters of the Kapuni Stream in my study compared to studies in 1982. Previous erosion events in the headwaters of the Stony River have also resulted in sedimentation to this river site (Taranaki Regional Council 1999), resulting in the degradation of water quality.

It may be possible that methodological differences and seasonal variability between surveys has contributed to some of the above changes in invertebrate communities. Moore (1998) noted that volume-based methods, such as those used in my study, provide higher numbers of taxa and higher numbers of individuals per sample than the time-limited sampling methods used in 1958 and the 1980's. This may explain why the number of taxa was considerably higher within my survey compared to studies in the 1980's. My samples were also taken over a cross section of microhabitats (as opposed to a single microhabitat) and this may have led to a larger representative sample of the riffle reach of benthic communities.

In summary, this study examined changes in macroinvertebrate communities on the Taranaki Ring Plain, New Zealand, and found that there has been a general reduction in water quality since 1958 and the 1980s. This included an increase of *Oxyethira*, Oligochaete and *Tanytarsini* species, and a decrease of *Deleatidium* spp., *Beraeoptera* and *Coloburiscus* in many streams. Changes in the structure of benthic communities on the Ring Plain can mostly be attributed to the intensification of agricultural practices, whilst the closure of dairy factories, changes in the flow regime, and the movement of sand, has caused some localised effects.

SYNTHESIS

A longitudinal continuum exists on the Taranaki Ring Plain from high altitude forested headwater streams, through to low altitude pastoral streams draining intensive dairying and industrial practices. Catchment land use is the underlying factor which has had a marked influence on benthic invertebrate communities of the Ring Plain streams. The percentage of catchment in native forest correlated positively with altitude, and negatively with turbidity, conductivity, BOD and chlorophyll a. This resulted in a marked reduction of macroinvertebrate taxonomic richness, and the replacement of enrichment-sensitive mayfly and stonefly species with more tolerant Dipteran and molluscan species, in a down stream direction on the Ring Plain. In contrast, periphyton faunas became more diverse, and increased in biomass with distance downstream. Many stream sites scattered across the Ring Plain have experienced a decline in water quality since surveys by Hirsch (1958), Stark (1982) and the Taranaki Catchment Commission (1982, 1984). The decline in water quality was indicated by a change to more enrichment tolerant macroinvertebrate communities such as *Oxyethira*, Oligochaete, and *Tanytarsini* species, whilst *Deleatidium* spp., *Beraeoptera* and *Coloburiscus* species have decreased. Changes in the structure of benthic communities on the Ring Plain were mostly attributed to the intensification of agricultural practices, whilst the closure of dairy factories, changes in the flow regime, and the movement of sand, caused localised effects. However sites which had been immediately downstream from severe diary factory and septic tank discharges in Hirsch's survey revealed a general recovery because of the closure of these dairy factories. The water quality of most of the headwater streams however, was similar to that of previous surveys, and continues to support pristine macroinvertebrate communities.

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APPENDIX 1

Location of 83 Taranaki Ring Plain Stream sites sampled from February to May 1998.

River/Stream	Location	Site No.	Site Code
Inaha S.	600m d/s Palmer Rd	A1	INH000120
	2.1km d/s Palmer Rd	A2	INH000125
	3.5Km d/s Eltham Rd	A3	INH000220
	Normanby Rd Bd	A4	INH000430
	SH45	A5	INH000470
	150m d/s SH45	A6	INH000473
Kaihihi S.	SH45	B1	KHH000380
Kahouri S.	2km u/s of SH3	C1	KHI000260
	SH3 Bd	C2	KHI000300
	d/s Flint Rd Bd	C3	KHI000400
	20m u/s of Piakau S. Confl.	C4	KHI000480
Kapoaiaia S.	Wiremu Rd, 30m u/s of Bd	D1	KPA000250
	Immed. U/s Pungarehu Dairy Fact.	D2	KPA000745
	100m u/s SH45	D3	KPA000755
	SH45a below Pungarehu Dairy Fact.	D4	KPA000760
Kaupokonui R.	Opunake Rd	E1	KPK000250
	250m u/s Kaponga oxp discharge	E2	KPK000500
	50m d/s Kaponga oxp outfall	E3	KPK000520
	1km d/s Kaponga oxp discharge	E4	KPK000550
	Skeet Rd Bd	E5	KPK000685
	Upper Glenn Rd	E6	KPK000880
	SH45	E7	KPK000900
Kapuni S.	Opunake Rd	F1	KPN000150
	Eltham Rd	F2	KPN000210
	Skeet Rd	F3	KPN000300
	SH45	F4	KPN000450
Manganui R.	3km u/s SH3	G1	MGN000150
	400m u/s Tariki Rd	G2	MGN000300
	300m d/s Tariki Power Diversion Weir	G3	MGN000320
Mangahume S.	Wiremu Rd Bd	H1	MHM000300
	Eltham Rd	H2	MHM000650
	SH45 Bd	H3	MHM000970
Maketawa S.	Opp. Denby Rd (2.2 km d/s National Park	I1	MKW000200
	SH3	I2	MKW000250
Mangaoraka S.	2km u/s Kaimiro	J1	MRK000110
	Opp. Union Rd	J2	MRK000380
	Devon Rd (SH3)	J3	MRK000480
Ngatoro S.	SH3	K1	NGT000300
Oaonui S.	Wiremu Rd 15m u/s of Bd	L1	OAN000250

	SH45	L2	OAN000900
Oakura R	Carring Rd, 20m u/s of Bd	M1	OKR000150
	SH45, 300m u/s of Bd	M2	OKR000475
Timaru S.	Carrington Rd	N1	TMR000150
	SH45, 100m u/s of Bd	N2	TMR000375
Otahi S.	Wiremu Road	01	OTH000100
	U/s Opunake Dairy Factory, SH45	02	OTH000370
Otakeho S.	Opunake Rd	P1	OTK000200
	Skeet Rd	P2	OTK000400
	50m d/s Skeet Rd	P3	OTK000403
	SH45	P4	OTK000900
Patea R.	Barclay Rd Bd	Q1	PAT000200
	Cardiff Rd Bd	Q2	PAT000225
	Brecon Rd	Q3	PAT000287
	500m u/s of Kahouri S. Conf.	Q4	PAT000357
	Skinner Rd Bd	Q5	PAT000360
Punehu S.	Opunake Rd	R1	PNH000210
	500m d/s Mangapapa S. Confl.	R2	PNH000800
Stony S.	Near end of Saunders Rd	S1	STY000260
	Wiremu Rd	S2	STY000280
	SH45	S3	STY000400
Te Popo S.	SH3, Midhurst	T1	TPP000170
Waiau S.	Wiremu Rd 10m d/s of Bd	U1	WAA000200
	Approx 250m u/s SH45 Bd	U2	WAA000447
Waiongana S.	Adj. Egmont Rd	V1	WGA000120
	2km u/s SH3	V2	WGA000170
	SH3A Bd	V3	WGA000260
	Manutahi Rd	V4	WGA000360
Waingongoro R.	Opunake Rd	W1	WGG000150
	End of Clifford Rd	W2	WGG000490
	350m d/s Riverlands discharge	W3	WGG000550
	Skeet Rd	W4	WGG000680
	300m u/s Mawhitiwhiti Rd	W5	WGG000778
	150m u/s SH45	W6	WGG000895
Waiwakaiho R.	Alfred Rd Track	X1	WKH000185
	700m u/s Confl. of Kaiauai S.	X2	WKH000475
	Burgess Park	X3	WKH000687
	60m u/s rimu St landfill	X4	WKH000860
Warea S.	Wiremu Rd, 20m u/s of Bd	Y1	WRE000150
	SH45 bd	Y2	WRE000450
Waitara R.	Bertrand Rd	Z1	WTR000800
	U/s Waitara Landfill	Z2	WTR000890
Waiweranui S.	Wiremu R, 100m d/s Bd	AA1	WWN000200
	SH45	AA2	WWN000900

APPENDIX 2

Differences between macroinvertebrate classification and taxonomic resolution between the data sets of Hirsch (1958), the Taranaki Catchment Commission (1982, 1984), Stark (1984) and Wells (1998).

STARK	WELLS	HIRCHE
ANNELIDA	ANNELIDA	ANNELIDA
Oliochaeta	Oliochaeta	Tubificidae
		Naididae
Oliochaeta	Eiseniella	Eiseniella
Hirudinea	Hirudinea	Glossiphonidae
PLATYHELMINTHES	PLATYHELMINTHES	PLATYHALMINTHES
	Cura	Curtisia stagnalis
	Neppia	
MOLLUSCA	MOLLUSCA	
Latia neritoides sp	Latia	
	Ferrissia	
Potamopyrgus antipodanum	Potamopyrgus	*Potamopyrgus sp*
	Gyraulus	Planorbis corinna
Physa acuta	Physa	
	Physastra	
	Sphaeriidae	
	Lymnaea	
Melanopsis trifasciata	Melanopsis	
CRUSTACEA	CRUSTACEA	
	Copepoda	
Herpetocypris pascheri	Ostracoda	Ostracoda
	Isopoda	
Paracalliope fluviatilis	Paracalliope	*Paracalliope fluviatilis*
Paraleptamphopus subterraneus	Paraleptamphopus	
	Parenephrops	*Paranephros sp.*
	Paratya	
Gammaropsis sp.	Gammaridae	
EPHEMEROPTERA	EMPHEMEROPTERA	
Coloburiscus humeralis	Coloburiscus	Coloburiscus
	Oniscigaster	
Nesameletus sp	Nesmeletus	Nesmeletus
Zephlebia sp	Zephlebia group	
Austraclima spp	Austraclima	
Mauiulus luma		
Deleatidium spp.	Deleatidium	Deleatidium
	Ameletopsis	
	Ichthybotus	
PLECOPTERA	PLECOPTERA	
Zelandoperla decorata	*Zelandoperla*	
Z. agnetis		
Zelandobius confusus	*Zelandobius*	
Z.. furcillatus		
Z. unicolor		
Z. spp.		
Stenoperla prasina	*Stenoperla*	
S. maclellani		
	Austroperla	
Megaleptoperla grandis	*Megaleptoperla*	
M. diminuta		
Acroperla sp	*Acroperla*	
	ODONATA	

	Xanthocnemis	
COLEOPTERA	COLEOPTERA	COLEOPTERA
Elmidae	*Elmidae*	*Hydora*
Hydraenidae	*Hydraenidae*	
Hydrophilidae	*Hydrophilidae*	
Staphylinidae	*Staphylinidae*	
	Dytiscidae	
Ptilodactylidae	*Ptilodactylidae*	
	Helodidae	
HEMIPTERA	HEMIPTERA	
	Saldula	
Sigara sp.	*Sigara*	
Microvelia	*Microvelia*	
MEGALOPTERA	MEGALOPTERA	MEGALOPTERA
Archichauliodes diversus	*Archichauliodes*	*Archichauliodes*
TRICHOPTERA	TRICHOPTERA	TRICHOPTERA
Aoteapsyche sp	*Aoteapsyche*	*Aoteapsyche*
Orthopsyche fimbriata	*Orthopsyche*	*Orthopsyche*
O. thomasi		
Hydrobiosis clavigera	*Hydrobiosis*	*Hydrobiosis clavigera*
H. parumbripennis		*H. parumbripennis*
H. umbripennis		*H. umbripennis*
H. spp		*Hydrobiosis species*
Tiphobiosis spp.		
Pycnocentrodes spp.	*Pycnocentrodes*	*Pycnocentrodes group*
Olinga feredayi	*Olinga*	*Olinga group*
Helicopsyche albescens	*Helicopsyche*	*Helicopsyche sp.*
Oxyethira albiceps	*Oxyethira*	*Hydroptilidae*
Paroxyethira hendersoni	*Paroxyethira*	*Hydroptilidae*
Polyplectropus spp.	*Polyplectropus*	*Polycentropodidae*
Hydrochorema crassicaudatum	*Hydrochorema*	
Costachorema callistum	*Costachorema*	*Costachorema xanthoptera*
C. xanthoptera		
C. spp.		
Psilochorema sp.	*Psilochorema*	*Psilochorema leptoharpax*
		Psilochorema mimicum
		Psilochorema sp.
Neurochorema spp.	Neurochorema	*N. confusum*
	Tiphobiosis	*Neurochorema sp.*
	Hydrobiosella	
Pycnocentria evecta	Pycnocentria	
P. spp.		
Beraeoptera roria	Beraeoptera	*Beraeoptera roria*
Confluens hamiltoni	Confluens	
	Zelolessica	
Triplectides obsoleta	Triplectides	
Oeconesidae	Oeconesidae	
Conuxia gunni	Conuxia	
DIPTERA	DIPTERA	
Aphrophila neozelandica	Aphrophila	Tipulidae
Eropterini	Eropterini	
	Hexatomini	*Other Diptera*
Empididae	Empididae	
Anthomyiidae	Anthomyiidae	
	Tabanidae	
Stratiomyidae	Stratiomyidae	
Tanyderidae	Tanyderidae	
Mischoderus sp.		
	Ephydridae	Ephydridae
Psychodidae	Psychodidae	Psychodidae

Chironomous sp	Chironomous	*Chironomous zealandicus*
Maoridiamesa spp.	Maoridiamesa	Other Chironomidae
Orthocladiinae	Orthocladiinae	
Tanytarsini	Tanytarsini	
Tanypodinae	Tanypodinae	
Polypedilum spp.	Polypedilum	
	Harrisius	
Austrosimulium spp.	Austrosimulium	*A. australense*
Ceratogoonidae	Ceratopogonidae	
Chironomous zealandicus	Chironomous	
	ACARINA	

APPENDIX 3: Macroinvertebrate fauna of the Inaha Stream collected in a kick net on 26 March (^), and 05 May (*) 1998 in 6 Ring Plain stream sites.

SITE	*	^	^	^	
Site Code INH000	120	125	220	430	
COELENTERATA					
PLATYHELMINTHES					
Cura	R	-	-	R	
Neppia	-	C	-	-	
Rhabdocoela					
NEMERTEA	-	C	C	C	
NEMATODA	R	-	R	-	
NEMATOMORPHA					
ANNELIDA					
Oligochaeta	R	A	A	A	
Eiseniella	-	R	R	A	
Hirudinea					
MOLLUSCA					
Latia					
Ferrissia					
Potamopyrgus	-	R	C	R	
Gyraulus					
Physa					
Physastra					
Sphaeriidae					
Lymnaea					
CRUSTACEA					
Copepoda					
Cladocera					
Ostracoda					
Isopoda					
Paracalliope	-	-	R	R	
Paraleptamphopus					
Gammaridae					
Paratya					
Paranephrops	-	-	R	-	
EPHEMEROPTERA					
Ameletopsis					
Ichthybotus					
Nesameletus	A	C	-	-	
Coloburiscus	A	A	A	-	
Oniscigaster					
Deleatidium	A	C	-	-	
Mauiulus					
Austroclima	-	A	A	-	
Zephlebia group	R	R	R	-	
Acanthophlebia cruentata					
PLECOPTERA					
Stenoperla					
Austroperla	-	R	-	-	
Megaleptoperla	R	R	-	-	
Zelandoperla					
Zelandobius	C	-	-	-	
Acroperla					
A.spiniger					
Spaniocerca					
ODONATA					
Austrolestes					
Xanthocnemis					
Ischnura					
Hemicordulia					
Antipodochlora					
COLEOPTERA					
Hydraenidae	C	C	R	R	
Hydrophilidae					
Elmidae	A	A	A	-	
Staphylinidae					
Dytiscidae					
Ptilodactylidae	A	A	-	-	
Scritidae	R	-	-	-	

SITE					
HEMIPTERA					
Anisops					
Saldula					
Sigara					
Microvelia					
MEGALOPTERA					
Archichauliodes	C	A	A	R	
TRICHOPTERA					
Orthopsyche	A	C	-	-	
Aoteapsyche	-	C	A	C	
Ecnomidae					
Polyplectropus					
Hydrobiosis	C	C	R	-	
Psilochorema	-	R	-	-	
Neurochorema					
Costachorema	-	-	-	R	
Hydrochorema	R	-	-	-	
Hydrobiosella					
Oxyethira	-	R	-	R	
Paroxyethira					
Pycnocentria	C	A	C	-	
Beraeoptera	R	R	-	-	
Pycnocentrodes	-	R	-	-	
Confluens					
Zelolessica	C	R	-	-	
Olinga					
Helicopsyche					
Triplectides					
Hudsonema					
Oeconesidae	-	C	-	-	
Oecetis					
LEPIDOPTERA					
Hygraula					
DIPTERA					
Limonia					
Aphrophila	A	A	R	-	
Zelandotipula					
Eriopterini	A	C	-	-	
Hexatomini	-	-	R	-	
Paralimnophila					
Pedicia					
Tanypodinae	-	C	-	-	
Maoridiamesa	-	-	R	R	
Orthocladiinae	C	A	C	A	
Tanytarsini					
Chironomus					
Polypedilum					
Harrisius	-	-	R	R	
Ceratopogonidae					
Austrosimulium	R	R	A	A	
Paradixa					
Empididae	R	-	-	-	
Anthomyiidae	C	R	-	-	
Psychodidae					
Culicidae					
Tabanidae					
Ephydridae					
Stratiomyidae					
Sciomyzidae					
Tanyderidae	-	C	-	-	
Syrphidae					
ACARINA	R	-	-	R	
No of taxa	27	33	22	16	
MCI	119	115	98	85	
SQMCI	6.3	5.7	4.8	3.5	
EPT	12	17	6		

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

acroinvertebrate fauna of the Inaha Stream collected in a kick net on 25 March (*) and the 06 May (^) 1998 in 6 Ring Plain ream sites.

SITE	*		^			SITE					
Site Code INH000	470		473			HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura	C		C			*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*					
NEMERTEA	C		C			TRICHOPTERA					
NEMATODA						*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*					
ANNELIDA						Ecnomidae					
Oligochaeta	A		A			*Polyplectropus*					
Eiseniella	R		R			*Hydrobiosis*	A		R		
Hirudinea	C		A			*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*					
Ferrissia	A		A			*Hydrochorema*					
Potamopyrgus	XA		-			*Hydrobiosella*					
Gyraulus						*Oxyethira*	-		A		
Physa	R		A			*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae	C		R			*Beraeoptera*					
Lymnaea						*Pycnocentrodes*	C		R		
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda	R		-			*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope	-		R			*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*	-		A		
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	A		-		
Nesameletus						*Zelandotipula*					
Coloburiscus						Eriopterini					
Oniscigaster						Hexatomini					
Deleatidium						*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima						Tanypodinae					
Zephlebia group						*Maoridiamesa*					
Acanthophlebia cruentata						Orthocladiinae	A		A		
PLECOPTERA						Tanytarsini	R		-		
Stenoperla						*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla						*Harrisius*					
Zelandoperla						Ceratopogonidae					
Zelandobius						*Austrosimulium*	R		A		
Acroperla						*Paradixa*					
A.spiniger						Empididae					
Spaniocerca						Anthomyiidae					
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis	-		C			Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae						Syrphidae					
Hydrophilidae						ACARINA					
Elmidae	A		A			No of taxa	17		17		
Staphylinidae						MCI	68		72		
Dytiscidae						SQMCI	3.2		3.3		
Ptilodactylidae						EPT	2		3		
Scritidae											

= Rare C (0-5 taxa), = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Kaihihi Stream collected in a kick net on the 05 May 1998 in 1 Ring Plain stream site.

SITE							SITE						
Site Code	KHH000	380					HEMIPTERA						
							Anisops						
COELENTERATA							*Saldula*						
PLATYHELMINTHES							*Sigara*						
Cura		A					*Microvelia*						
Neppia							MEGALOPTERA						
Rhabdocoela							*Archichauliodes*	C					
NEMERTEA		A					TRICHOPTERA						
NEMATODA		C					*Orthopsyche*						
NEMATOMORPHA							*Aoteapsyche*	A					
ANNELIDA							Ecnomidae						
Oligochaeta		A					*Polyplectropus*						
Eiseniella							*Hydrobiosis*	C					
Hirudinea							*Psilochorema*						
MOLLUSCA							*Neurochorema*						
Latia							*Costachorema*	R					
Ferrissia							*Hydrochorema*						
Potamopyrgus		A					*Hydrobiosella*						
Gyraulus							*Oxyethira*	A					
Physa							*Paroxyethira*						
Physastra							*Pycnocentria*						
Sphaeriidae							*Beraeoptera*						
Lymnaea							*Pycnocentrodes*	R					
CRUSTACEA							*Confluens*						
Copepoda							*Zelolessica*						
Cladocera							*Olinga*						
Ostracoda							*Helicopsyche*						
Isopoda							*Triplectides*						
Paracalliope		A					*Hudsonema*						
Paraleptamphopus							Oeconesidae						
Gammaridae							*Oecetis*						
Paratya							LEPIDOPTERA						
Paranephrops							*Hygraula*						
EPHEMEROPTERA							DIPTERA						
Ameletopsis							*Limonia*						
Ichthybotus							*Aphrophila*	A					
Nesameletus							*Zelandotipula*						
Coloburiscus		R					Eriopterini						
Oniscigaster							Hexatomini						
Deleatidium		R					*Paralimnophila*						
Mauiulus							*Pedicia*						
Austroclima							Tanypodinae						
Zephlebia group							*Maoridiamesa*	A					
Acanthophlebia cruentata							Orthocladiinae	A					
PLECOPTERA							Tanytarsini	A					
Stenoperla							*Chironomus*						
Austroperla							*Polypedilum*						
Megaleptoperla							*Harrisius*						
Zelandoperla							Ceratopogonidae						
Zelandobius							*Austrosimulium*	A					
Acroperla							*Paradixa*						
A.spiniger							Empididae	A					
Spaniocerca							Anthomyiidae	A					
ODONATA							Psychodidae						
Austrolestes							Culicidae						
Xanthocnemis							Tabanidae						
Ischnura							Ephydridae	R					
Hemicordulia							Stratiomyidae						
Antipodochlora							Sciomyzidae						
COLEOPTERA							Tanyderidae						
Hydraenidae							Syrphidae						
Hydrophilidae							ACARINA						
Elmidae		R					No of taxa	23					
Staphylinidae							MCI	83					
Dytiscidae							SQMCI	3.6					
Ptilodactylidae							EPT	7					
Scritidae													

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Kahouri Stream collected in a kick net on the 16 February (*), 10 March (^) and the 19 March (#) 1998 in 4 Ring Plain stream sites.

SITE	^	#	*	*		SITE					
Site Code KHI000	260	300	400	480		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	A	C	A	C	
NEMERTEA	-	R	-	-		TRICHOPTERA					
NEMATODA						*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A	C	A	A	
ANNELIDA						Ecnomidae					
Oligochaeta	A	C	A	A		*Polyplectropus*	R	-	-	-	
Eiseniella	C	R	-	-		*Hydrobiosis*	C	R	C	C	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*	R	-	R	-	
Latia						*Costachorema*	C	R	A	A	
Ferrissia						*Hydrochorema*					
Potamopyrgus	R	R	-	R		*Hydrobiosella*					
Gyraulus						*Oxyethira*	-	-	A	R	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*	-	-	R	-	
Lymnaea						*Pycnocentrodes*					
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*					
Isopoda	-	R	-	-		*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae	R	-	-	-	
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis	R	-	-	-		*Limonia*					
Ichthybotus						*Aphrophila*	A	A	A	A	
Nesameletus	A	R	A	R		*Zelandotipula*					
Coloburiscus	A	A	A	-		Eriopterini	R	-	R	-	
Oniscigaster						Hexatomini					
Deleatidium	XA	C	C	R		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	R	C	A	-		Tanypodinae	R	-	R	-	
Zephlebia group						*Maoridiamesa*	R	-	C	C	
Acanthophlebia cruentata						Orthocladiinae	A	R	A	A	
PLECOPTERA						Tanytarsini	R	-	A	A	
Stenoperla	R	-	-	-		*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla						*Harrisius*					
Zelandoperla	C	C	C	-		Ceratopogonidae					
Zelandobius						*Austrosimulium*	R	R	A	A	
Acroperla						*Paradixa*					
A.spiniger						Empididae	C	-	A	C	
Spaniocerca						Anthomyiidae	-	-	R	R	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae	R	-	-	-	
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	C	R	R	R	
Hydraenidae	C	R	C	-		Syrphidae					
Hydrophilidae						ACARINA	R	R	A	R	
Elmidae	A	A	A	A		No of taxa	32	21	26	20	
Staphylinidae						MCI	113	108	103	92	
Dytiscidae						SQMCI	5.6	5.7	5.0	4.2	
Ptilodactylidae	R	-	-	R		EPT	13	8	8	7	
Scritidae	R	-	-	-							

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Kapoaiaia Stream collected in a kick net on the 23 March (*) and the 06 May (^) 1998 in 4 Ring. Plain stream sites.

SITE	*	*	^	*		SITE					
Site Code KPA000	250	745	755	760		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura	-	C	C	R		*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	C	C	C	C	
NEMERTEA	R	A	A	A		TRICHOPTERA					
NEMATODA	C	-	R	-		*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A	R	R	R	
ANNELIDA						Ecnomidae					
Oligochaeta	A	A	A	A		*Polyplectropus*					
Eiseniella	-	-	R	-		*Hydrobiosis*	R	C	C	-	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*	R	-	-	-	
Ferrissia						*Hydrochorema*					
Potamopyrgus	R	A	A	A		*Hydrobiosella*					
Gyraulus						*Oxyethira*	A	A	A	A	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*	R	-	-	-	
Lymnaea						*Pycnocentrodes*	R	R	-	-	
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*	R	-	-	-	
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope	-	C	C	-		*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis	-	-	-	R		*Limonia*					
Ichthybotus						*Aphrophila*	A	A	A	A	
Nesameletus	C	-	-	-		*Zelandotipula*					
Coloburiscus	C	R	-	R		Eriopterini	R	-	-	-	
Oniscigaster						Hexatomini					
Deleatidium	-	-	R	-		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	C	-	-	-		Tanypodinae	R	R	-	-	
Zephlebia group						*Maoridiamesa*	C	-	R	-	
Acanthophlebia cruentata						Orthocladiinae	A	A	A	A	
PLECOPTERA						Tanytarsini	R	A	A	-	
Stenoperla						*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla	R	-	-	-		*Harrisius*					
Zelandoperla	R	-	-	-		Ceratopogonidae					
Zelandobius						*Austrosimulium*	C	A	A	A	
Acroperla						*Paradixa*					
A.spiniger						Empididae	C	A	-	R	
Spaniocerca						Anthomyiidae	C	A	C	C	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	R	R	R	-	
Hydraenidae	R	R	-	-		Syrphidae					
Hydrophilidae						ACARINA	R	-	-	-	
Elmidae	A	A	C	C		No of taxa	30	21	20	15	
Staphylinidae						MCI	102	84	79	84	
Dytiscidae						SQMCI	4.5	3.7	3.6	3.6	
Ptilodactylidae						EPT	12	5	4	4	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Kaupokonui River collected in a kick net on the 24 March 1998 in 7 Ring Plain stream sites.

SITE						SITE					
Site Code	KPK000	250	500	520	550	HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	A	C	A	C	
NEMERTEA		-	C	A	A	TRICHOPTERA					
NEMATODA		-	R	-	R	*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	XA	A	A	A	
ANNELIDA						Ecnomidae					
Oligochaeta		R	A	C	A	*Polyplectropus*					
Eiseniella						*Hydrobiosis*	C	C	C	R	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*	R	R	R	R	
Latia						*Costachorema*	R	R	C	C	
Ferrissia						*Hydrochorema*					
Potamopyrgus		R	-	R	-	*Hydrobiosella*					
Gyraulus						*Oxyethira*	-	R	R	C	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*	R	-	-	-	
Sphaeriidae						*Beraeoptera*	R	C	C	C	
Lymnaea						*Pycnocentrodes*	C	R	R	C	
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*	-	R	-	-	
Cladocera						*Olinga*	A	-	-	-	
Ostracoda						*Helicopsyche*	R	-	-	-	
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	A	A	A	A	
Nesameletus		C	R	-	R	*Zelandotipula*					
Coloburiscus		XA	R	C	R	Eriopterini	C	-	-	-	
Oniscigaster						Hexatomini					
Deleatidium		XA	-	-	-	*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima		C	R	R	R	Tanypodinae					
Zephlebia group						*Maoridiamesa*	-	A	A	A	
Acanthophlebia cruentata						Orthocladiinae	A	A	A	A	
PLECOPTERA						Tanytarsini	-	C	A	C	
Stenoperla		C	-	-	-	*Chironomus*					
Austroperla		R	-	-	-	*Polypedilum*					
Megaleptoperla		A	-	-	-	*Harrisius*					
Zelandoperla		XA	R	R	R	Ceratopogonidae					
Zelandobius						*Austrosimulium*	-	R	-	C	
Acroperla						*Paradixa*					
A.spiniger						Empididae	-	R	R	R	
Spaniocerca						Anthomyiidae	R	C	R	R	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae	-	-	R	-	
Ischnura						Ephydridae	-	-	-	R	
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae		A	-	-	R	Syrphidae					
Hydrophilidae						ACARINA					
Elmidae		A	A	A	A	No of taxa	26	24	22	25	
Staphylinidae						MCI	130	98	93	93	
Dytiscidae						SQMCI	6.6	4.4	4.5	4.5	
Ptilodactylidae						EPT	17	12	10	11	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Kaupokonui River collected in a kick net on the 24 March (*) and the 06 May (^) 1998 in 7 Ring Plain stream sites.

SITE	*		*		^
Site Code KPK000	685		880		900
COELENTERATA					
PLATYHELMINTHES					
Cura	-		-		C
Neppia					
Rhabdocoela					
NEMERTEA	A		A		A
NEMATODA	-		-		R
NEMATOMORPHA					
ANNELIDA					
Oligochaeta	A		A		A
Eiseniella	-		-		-
Hirudinea					
MOLLUSCA					
Latia					
Ferrissia					
Potamopyrgus	R	-	A		A
Gyraulus					
Physa	C	-	A		A
Physastra					
Sphaeriidae					
Lymnaea					
CRUSTACEA					
Copepoda					
Cladocera					
Ostracoda	-		R		-
Isopoda					
Paracalliope	-		-		R
Paraleptamphopus					
Gammaridae					
Paratya					
Paranephrops					
EPHEMEROPTERA					
Ameletopsis					
Ichthybotus					
Nesameletus					
Coloburiscus					
Oniscigaster					
Deleatidium					
Mauiulus					
Austroclima					
Zephlebia group					
Acanthophlebia cruentata					
PLECOPTERA					
Stenoperla					
Austroperla					
Megaleptoperla					
Zelandoperla					
Zelandobius					
Acroperla					
A.spiniger					
Spaniocerca					
ODONATA					
Austrolestes					
Xanthocnemis					
Ischnura					
Hemicordulia					
Antipodochlora					
COLEOPTERA					
Hydraenidae					
Hydrophilidae					
Elmidae	R		R		A
Staphylinidae					
Dytiscidae					
Ptilodactylidae					
Scritidae					

SITE					
HEMIPTERA					
Anisops					
Saldula					
Sigara					
Microvelia					
MEGALOPTERA					
Archichauliodes	C		R		C
TRICHOPTERA					
Orthopsyche					
Aoteapsyche	R		R		C
Ecnomidae					
Polyplectropus					
Hydrobiosis	-		-		C
Psilochorema					
Neurochorema					
Costachorema					
Hydrochorema					
Hydrobiosella					
Oxyethira	A		C		A
Paroxyethira					
Pycnocentria					
Beraeoptera					
Pycnocentrodes					
Confluens					
Zelolessica					
Olinga					
Helicopsyche					
Triplectides					
Hudsonema					
Oeconesidae					
Oecetis					
LEPIDOPTERA					
Hygraula					
DIPTERA					
Limonia					
Aphrophila	A		A		C
Zelandotipula					
Eriopterini					
Hexatomini					
Paralimnophila					
Pedicia					
Tanypodinae					
Maoridiamesa	R		-		R
Orthocladiinae	A		XA		A
Tanytarsini	-		-		C
Chironomus					
Polypedilum					
Harrisius					
Ceratopogonidae					
Austrosimulium	-		C		C
Paradixa					
Empididae					
Anthomyiidae	R		R		C
Psychodidae					
Culicidae					
Tabanidae					
Ephydridae	R		C		-
Stratiomyidae					
Sciomyzidae					
Tanyderidae					
Syrphidae					
ACARINA					
No of taxa	13		14		18
MCI	72		71		72
SQMCI	3.2		3.2		3.5
EPT	2		2		3

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Kapuni Stream collected in a kick net on 16 April (*) and the 17 (^) April 1998 in 4 Ring Plain stream sites.

SITE	*	^	*	*		SITE					
Site Code KPN000	150	210	300	450		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura	-	-	C	R		*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	C	A	A	C	
NEMERTEA	-	R	A	A		TRICHOPTERA					
NEMATODA						*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A	A	XA	A	
ANNELIDA						Ecnomidae					
Oligochaeta	A	A	A	A		*Polyplectropus*					
Eiseniella	-	R	R	C		*Hydrobiosis*	R	C	C	C	
Hirudinea						*Psilochorema*	R	-	-	-	
MOLLUSCA						*Neurochorema*	R	R	-	-	
Latia	-	-	-	R		*Costachorema*	-	C	C	-	
Ferrissia	-	-	C	-		*Hydrochorema*					
Potamopyrgus	-	C	A	A		*Hydrobiosella*					
Gyraulus						*Oxyethira*	-	R	-	C	
Physa	-	-	-	R		*Paroxyethira*					
Physastra						*Pycnocentria*	-	R	-	-	
Sphaeriidae						*Beraeoptera*	A	A	A	-	
Lymnaea						*Pycnocentrodes*	-	A	A	C	
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*	C	R	-	-	
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	A	A	A	C	
Nesameletus	R	A	-	-		*Zelandotipula*					
Coloburiscus	A	A	A	-		Eriopterini	C	A	A	R	
Oniscigaster						Hexatomini					
Deleatidium	A	A	C	-		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	-	R	A	R		Tanypodinae					
Zephlebia group	-	-	-	R		*Maoridiamesa*	-	R	A	R	
Acanthophlebia cruentata						Orthocladiinae	R	A	A	-	
PLECOPTERA						Tanytarsini	-	-	-	R	
Stenoperla	C	-	-	-		*Chironomus*					
Austroperla	R	R	-	-		*Polypedilum*					
Megaleptoperla	A	R	-	-		*Harrisius*					
Zelandoperla	A	A	-	-		Ceratopogonidae					
Zelandobius	R	-	-	-		*Austrosimulium*	-	R	R	C	
Acroperla						*Paradixa*					
A.spiniger						Empididae	-	-	R	R	
Spaniocerca						Anthomyiidae	R	R	-	-	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae	-	R	-	R	
Ischnura						Ephydridae				R	
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	-	C	R	R	
Hydraenidae	C	C	R	-		Syrphidae					
Hydrophilidae	-	-	-	R		ACARINA					
Elmidae	A	A	XA	A		No of taxa	22	32	24	25	
Staphylinidae						MCI	127	113	97	84	
Dytiscidae						SQMCI	6.5	5.7	4.8	4.1	
Ptilodactylidae	-	R	-	-		EPT	14	16	8	6	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Manganui River collected in a kick net on the 23 March (*), 26 March (^) and the 06 May (#) 1998 in 3 Ring Plain stream sites.

SITE	*		#		^	SITE					
Site Code MGN000	150		300		320	HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura	-		-		R	*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	R		C		A
NEMERTEA	-		-		C	TRICHOPTERA					
NEMATODA	-		R		-	*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	C		C		A
ANNELIDA						Ecnomidae					
Oligochaela	C		A		A	*Polyplectropus*					
Eiseniella						*Hydrobiosis*	-		-		R
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*	-		R		R
Ferrissia						*Hydrochorema*					
Potamopyrgus	-		-		R	*Hydrobiosella*					
Gyraulus						*Oxyethira*	-		C		A
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*	R		R		R
Lymnaea						*Pycnocentrodes*					
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*	R		-		-
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope	-		-		R	*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya	-		R		-	LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	R		C		A
Nesameletus	A		R		-	*Zelandotipula*					
Coloburiscus	R		-		C	Eriopterini	C		-		-
Oniscigaster						Hexatomini					
Deleatidium	A		-		R	*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	-		-		C	Tanypodinae					
Zephlebia group						*Maoridiamesa*	-		A		-
Acanthophlebia cruentata						Orthocladiinae	R		A		A
PLECOPTERA						Tanytarsini	-		C		A
Stenoperla						*Chironomus*					
Austroperla	-		R		-	*Polypedilum*					
Megaleptoperla	C		-		-	*Harrisius*					
Zelandoperla	C		C			Ceratopogonidae					
Zelandobius						*Austrosimulium*	-		C		C
Acroperla						*Paradixa*					
A.spiniger						Empididae	-		R		-
Spaniocerca						Anthomyiidae	-		R		-
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae	-		-		R
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	R		-		-
Hydraenidae	R		-		R	Syrphidae					
Hydrophilidae						ACARINA	-	-	C		R
Elmidae	A		C		R	No of taxa	17		20		22
Staphylinidae						MCI	127		94		97
Dytiscidae						SQMCI	6.5		4.1		4.2
Ptilodactylidae						EPT	8		7		8
Scritidae	R		-		-						

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Mangahume Stream collected in a kick net on the 05 March 1988 in 3 Ring Plain stream sites.

SITE						SITE					
Site Code MHM000	300		650		970	HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	-		-		C
NEMERTEA						TRICHOPTERA					
NEMATODA	-		R		R	*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	-		-		R
ANNELIDA						Ecnomidae					
Oligochaeta	-		R		A	*Polyplectropus*					
Eiseniella						*Hydrobiosis*	-		-		R
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*					
Ferrissia						*Hydrochorema*					
Potamopyrgus						*Hydrobiosella*					
Gyraulus						*Oxyethira*	-		-		A
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*					
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	-		-		A
Nesameletus						*Zelandotipula*					
Coloburiscus	R		-		R	Eriopterini	-		-		R
Oniscigaster						Hexatomini					
Deleatidium	R		-		R	*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima						Tanypodinae					
Zephlebia group						*Maoridiamesa*					
Acanthophlebia cruentata						Orthocladiinae	-		C		A
PLECOPTERA						Tanytarsini					
Stenoperla						*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla						*Harrisius*					
Zelandoperla	R		-		R	Ceratopogonidae					
Zelandobius						*Austrosimulium*	-		-		C
Acroperla						*Paradixa*					
A.spiniger						Empididae	-		R		R
Spaniocerca						Anthomyiidae					
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae						Syrphidae					
Hydrophilidae						ACARINA	-		-		R
Elmidae	C		C		A	No of taxa	5		5		16
Staphylinidae						MCI	148		60		93
Dytiscidae						SQMCI	7.0		3.4		4.0
Ptilodactylidae	R		-		-	EPT	3		0		6
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa). XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Maketawa Stream collected in a kick net on 06 March 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code MKW000	200		250			HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	R		C		
NEMERTEA						TRICHOPTERA					
NEMATODA						*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	C		A		
ANNELIDA						Ecnomidae					
Oligochaeta						*Polyplectropus*					
Eiseniella						*Hydrobiosis*	R		R		
Hirudinea						*Psilochorema*	R		-		
MOLLUSCA						*Neurochorema*	R		R		
Latia						*Costachorema*	R		C		
Ferrissia						*Hydrochorema*					
Potamopyrgus						*Hydrobiosella*					
Gyraulus						*Oxyethira*					
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*	R		C		
Lymnaea						*Pycnocentrodes*	R		A		
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*	-		R		
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops	R		-			*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	-		A		
Nesameletus	A		C			*Zelandotipula*					
Coloburiscus	R		A			Eriopterini	R		R		
Oniscigaster						Hexatomini					
Deleatidium	XA		A			*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	-		C			Tanypodinae	R		R		
Zephlebia group						*Maoridiamesa*	-		C		
Acanthophlebia cruentata						Orthocladiinae	-		C		
PLECOPTERA						Tanytarsini	-		C		
Stenoperla						*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla	C		C			*Harrisius*					
Zelandoperla	R		C			Ceratopogonidae					
Zelandobius						*Austrosimulium*	R		R		
Acroperla						*Paradixa*					
A.spiniger						Empididae	-		R		
Spaniocerca						Anthomyiidae	R		-		
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae	-		R			Syrphidae					
Hydrophilidae						ACARINA	-		R		
Elmidae	A		A			No of taxa	19		25		
Staphylinidae						MCI	122		118		
Dytiscidae						SQMCI	6.7		6.0		
Ptilodactylidae						EPT	12		13		
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Mangaoraka Stream sampled on the 07 march (*) and the 27 March (^) 1998 in 3 Ring Plain stream sites.

SITE	*		^		^	SITE					
Site Code MRK000	110		380		480	HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura	-		-		A	*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	C		A		C
NEMERTEA	-		A		A	TRICHOPTERA					
NEMATODA	-		R		R	*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A		A		R
ANNELIDA						Ecnomidae					
Oligochaeta	A		A		A	*Polyplectropus*					
Eiseniella	C		R		R	*Hydrobiosis*	-		C		C
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia	-		-		A	*Costachorema*	-		R		-
Ferrissia						*Hydrochorema*					
Potamopyrgus	R		R		XA	*Hydrobiosella*					
Gyraulus						*Oxyethira*	R		A		A
Physa	-		-		R	*Paroxyethira*					
Physastra						*Pycnocentria*	-		-		R
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*	-		-		A
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope	-		-		R	*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis	R		-		-	*Limonia*					
Ichthybotus						*Aphrophila*	C		A		C
Nesameletus	-		-		R	*Zelandotipula*					
Coloburiscus	C		-		-	Eriopterini					
Oniscigaster						Hexatomini					
Deleatidium	C		-		-	*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	R		-		-	Tanypodinae					
Zephlebia group						*Maoridiamesa*	-		C		-
Acanthophlebia cruentata						Orthocladiinae	A		A		A
PLECOPTERA						Tanytarsini	-		A		A
Stenoperla						*Chironomus*					
Austroperla	R		-		-	*Polypedilum*					
Megaleptoperla						*Harrisius*					
Zelandoperla	R		R		-	Ceratopogonidae					
Zelandobius						*Austrosimulium*	A		A		A
Acroperla						*Paradixa*					
A.spiniger						Empididae	R		A		C
Spaniocerca	R		-		-	Anthomyiidae	R		C		R
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	R		C		-
Hydraenidae	R		-		-	Syrphidae					
Hydrophiliidae						ACARINA	-		R		-
Elmidae	C		A		R	No of taxa	22		22		23
Staphylinidae						MCI	111		85		83
Dytiscidae						SQMCI	4.8		3.8		3.5
Ptilodactylidae	R		R		-	EPT	9		5		6
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Ngatoro Stream collected in a kick net on 04 May 1998 in 1 Ring Plain stream site.

SITE						SITE					
Site Code NGT000	300					HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	C				
NEMERTEA	R					TRICHOPTERA					
NEMATODA						*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A				
ANNELIDA						Ecnomidae					
Oligochaeta	R					*Polyplectropus*					
Eiseniella						*Hydrobiosis*	R				
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*	C				
Ferrissia						*Hydrochorema*					
Potamopyrgus						*Hydrobiosella*					
Gyraulus						*Oxyethira*	R				
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*					
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	C				
Nesameletus						*Zelandotipula*					
Coloburiscus	R					Eriopterini					
Oniscigaster						Hexatomini					
Deleatidium	R					*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima						Tanypodinae					
Zephlebia group						*Maoridiamesa*	C				
Acanthophlebia cruentata						Orthocladiinae	A				
PLECOPTERA						Tanytarsini	A				
Stenoperla						*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla						*Harrisius*					
Zelandoperla	C					Ceratopogonidae					
Zelandobius						*Austrosimulium*	A				
Acroperla						*Paradixa*					
A.spiniger						Empididae	R				
Spaniocerca						Anthomyiidae					
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	R				
Hydraenidae						Syrphidae					
Hydrophilidae						ACARINA					
Elmidae	R					No of taxa	18				
Staphylinidae						MCI	90				
Dytiscidae						SQMCI	4.3				
Ptilodactylidae						EPT	7				
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Oaonui Stream collected in a kick net on the 14 April 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code	OAN000		250		900	HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*		R		-	
NEMERTEA						TRICHOPTERA					
NEMATODA			R		-	*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*					
ANNELIDA						Ecnomidae					
Oligochaeta			A		R	*Polyplectropus*					
Eiseniella						*Hydrobiosis*		R		R	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*					
Ferrissia						*Hydrochorema*					
Potamopyrgus			-		R	*Hydrobiosella*					
Gyraulus						*Oxyethira*		R		-	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*		R		-	
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*		C		-	
Nesameletus						*Zelandotipula*					
Coloburiscus						Eriopterini		-		R	
Oniscigaster						Hexatomini					
Deleatidium			-		C	*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima						Tanypodinae					
Zephlebia group						*Maoridiamesa*					
Acanthophlebia cruentata						Orthocladiinae		A		C	
PLECOPTERA						Tanytarsini					
Stenoperla						*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla						*Harrisius*					
Zelandoperla			-		A	Ceratopogonidae					
Zelandobius						*Austrosimulium*		-		R	
Acroperla						*Paradixa*					
A.spiniger						Empididae					
Spaniocerca						Anthomyiidae					
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae						Syrphidae					
Hydrophilidae						ACARINA					
Elmidae			A		C	No of taxa		9		9	
Staphylinidae						MCI		80		93	
Dytiscidae						SQMCI		3.6		5.6	
Ptilodactylidae						EPT		3		3	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Oakura River collected on the 20 April 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code OKR000		150		475		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*		R		C	
NEMERTEA		-		A		TRICHOPTERA					
NEMATODA		-		A		*Orthopsyche*		A		C	
NEMATOMORPHA						*Aoteapsyche*					
ANNELIDA						Ecnomidae					
Oligochaeta		R		A		*Polyplectropus*					
Eiseniella						*Hydrobiosis*		C		R	
Hirudinea						*Psilochorema*		R		-	
MOLLUSCA						*Neurochorema*				R	
Latia						*Costachorema*		R		R	
Ferrissia						*Hydrochorema*		R		-	
Potamopyrgus		-		R		*Hydrobiosella*		C		-	
Gyraulus						*Oxyethira*		-		A	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*		R		-	
Sphaeriidae						*Beraeoptera*		A		-	
Lymnaea						*Pycnocentrodes*		R		R	
CRUSTACEA						*Confluens*		R		-	
Copepoda						*Zelolessica*		C		-	
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*		A		-	
Isopoda		R		-		*Allocentrella*		R		-	
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya		-		A		LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*		C		A	
Nesameletus		A		-		*Zelandotipula*					
Coloburiscus		A		-		Eriopterini		-		R	
Oniscigaster						Hexatomini					
Deleatidium		A		-		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima		C		-		Tanypodinae					
Zephlebia group						*Maoridiamesa*		-		A	
Acanthophlebia cruentata						Orthocladiinae		A		A	
PLECOPTERA						Tanytarsini		-		A	
Stenoperla		C		-		*Chironomus*					
Austroperla		C		R		*Polypedilum*					
Megaleptoperla		C		-		*Harrisius*					
Zelandoperla		A		R		Ceratopogonidae					
Zelandobius		A		-		*Austrosimulium*		R		A	
Acroperla						*Paradixa*					
A.spiniger						Empididae		-		R	
Spaniocerca						Anthomyiidae		-		C	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae		-		C	
Hydraenidae		C		R		Syrphidae					
Hydrophilidae		R		-		ACARINA		-		R	
Elmidae		A		R		No of taxa		31		26	
Staphylinidae						MCI		135		90	
Dytiscidae						SQMCI		7.1		3.6	
Ptilodactylidae						EPT		22		8	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Timaru Stream collected in a kick net on the 23 March 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code TMR000		150		375		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*		C		C	
NEMERTEA						TRICHOPTERA					
NEMATODA						*Orthopsyche*		C		-	
NEMATOMORPHA						*Aoteapsyche*		-		A	
ANNELIDA						Ecnomidae					
Oligochaeta		-		A		*Polyplectropus*					
Eiseniella						*Hydrobiosis*		R		C	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*		-		C	
Latia						*Costachorema*		C		C	
Ferrissia						*Hydrochorema*					
Potamopyrgus		-		R		*Hydrobiosella*		C		-	
Gyraulus						*Oxyethira*		-		A	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*		-		R	
CRUSTACEA						*Confluens*		-		R	
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*		C		-	
Isopoda						*Triplectides*					
Paracalliope		-		R		*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis		R		-		*Limonia*					
Ichthybotus						*Aphrophila*		A		A	
Nesameletus		A		-		*Zelandotipula*					
Coloburiscus		A		R		Eriopterini		R		-	
Oniscigaster						Hexatomini					
Deleatidium		A		-		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima		R		C		Tanypodinae					
Zephlebia group						*Maoridiamesa*		R		A	
Acanthophlebia cruentata						Orthocladiinae		A		A	
PLECOPTERA						Tanytarsini		-		C	
Stenoperla		C		-		*Chironomus*					
Austroperla		R		-		*Polypedilum*					
Megaleptoperla		R		-		*Harrisius*					
Zelandoperla		A		C		Ceratopogonidae					
Zelandobius		A		-		*Austrosimulium*		R		A	
Acroperla						*Paradixa*					
A.spiniger						Empididae		-		A	
Spaniocerca						Anthomyiidae		-		A	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae		-		R	
Hydraenidae						Syrphidae					
Hydrophilidae						ACARINA					
Elmidae		C		A		No of taxa		22		26	
Staphylinidae						MCI		139		92	
Dytiscidae						SQMCI		7.0		4.2	
Ptilodactylidae		-		R		EPT		15		10	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Otahi Stream collected in a kick net on the 22 April (*) and the 05 May (^) 1998 in 2 Ring Plain stream sites.

SITE		^		*		SITE					
Site Code OTH000		100		370		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura		R		C		*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*		C		C	
NEMERTEA		A		A		TRICHOPTERA					
NEMATODA		-		R		*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*		R		C	
ANNELIDA						Ecnomidae					
Oligochaeta		A		A		*Polyplectropus*					
Eiseniella						*Hydrobiosis*		C		R	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*					
Ferrissia		-		C		*Hydrochorema*					
Potamopyrgus		A		A		*Hydrobiosella*					
Gyraulus						*Oxyethira*		A		A	
Physa		-		R		*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*		-		A	
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*		R		-	
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope		A		R		*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*		C		C	
Nesameletus		R		-		*Zelandotipula*					
Coloburiscus		R		-		Eriopterini					
Oniscigaster						Hexatomini					
Deleatidium						*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima						Tanypodinae					
Zephlebia group						*Maoridiamesa*		C		R	
Acanthophlebia cruentata						Orthocladiinae		A		A	
PLECOPTERA						Tanytarsini		-		C	
Stenoperla						*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla						*Harrisius*					
Zelandoperla		R		-		Ceratopogonidae					
Zelandobius						*Austrosimulium*		A		A	
Acroperla						*Paradixa*					
A.spiniger						Empididae		C		R	
Spaniocerca						Anthomyiidae		R		R	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae		R		-	
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae		R		-		Syrphidae					
Hydrophilidae						ACARINA					
Elmidae		C		A		No of taxa		22		21	
Staphylinidae						MCI		94		72	
Dytiscidae						SQMCI		3.9		3.5	
Ptilodactylidae						EPT		7.0		4	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Otakeho Stream collected in a kick net on the 16 April (*) and the 06 May (^) 1998 in 4 Ring Plain stream sites.

SITE	*	*	^	*		SITE					
Site Code OTK000	200	400	402	900		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura	-	R		R		*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	C	A	A	C	
NEMERTEA	-	C	A	C		TRICHOPTERA					
NEMATODA	R	-	C	R		*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A	A	A	C	
ANNELIDA						Ecnomidae					
Oligochaeta	A	A	A	A		*Polyplectropus*					
Eiseniella	-	-	-	R		*Hydrobiosis*	-	C	R	C	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*	R	-	-	-	
Latia						*Costachorema*	C	R	R	-	
Ferrissia						*Hydrochorema*					
Potamopyrgus	-	-	C	A		*Hydrobiosella*					
Gyraulus						*Oxyethira*	R	A	A	A	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*	R	-	-	-	
Sphaeriidae						*Beraeoptera*	A	-	-	-	
Lymnaea						*Pycnocentrodes*	A	-	R	R	
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*	R	-	-	-	
Ostracoda						*Helicopsyche*	R	-	-	-	
Isopoda						*Triplectides*					
Paracalliope	-	R	R	R		*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	A	C	A	C	
Nesameletus	A	-	-	-		*Zelandotipula*					
Coloburiscus	A	-	R	-		Eriopterini	A	-	-	-	
Oniscigaster						Hexatomini					
Deleatidium	A	-	-	-		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	C	R	-	-		Tanypodinae					
Zephlebia group						*Maoridiamesa*	A	A	A	C	
Acanthophlebia cruentata						Orthocladiinae	A	A	A	A	
PLECOPTERA						Tanytarsini	-	-	-	A	
Stenoperla	R	-	-	-		*Chironomus*					
Austroperla	R	-	-	-		*Polypedilum*					
Megaleptoperla	A	-	-	-		*Harrisius*					
Zelandoperla	A	R	-	-		Ceratopogonidae					
Zelandobius	R	-	-	-		*Austrosimulium*	-	R	A	R	
Acroperla						*Paradixa*					
A.spiniger						Empididae	-	R	C	-	
Spaniocerca						Anthomyiidae	R	A	C	R	
ODONATA						Psychodidae	R	-	-	-	
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae	-	-	R	-	
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	-	-	R	R	
Hydraenidae	C	-	R	-		Syrphidae					
Hydrophilidae						ACARINA					
Elmidae	A	A	A	A		No of taxa	29	19	23	20	
Staphylinidae						MCI	120	85	88	76	
Dytiscidae						SQMCI	5.9	3.8	3.8	3.6	
Ptilodactylidae	-	-	R	-		EPT	18	6	6	4	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Patea River collected in a kick net on the 12 (*), 13 (^) and 16 (#) February 1998 in 5 Ring Plain stream sites.

SITE	*	^	^	#	*	SITE					
Site Code PAT000	200	225	287	357	360	HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	C	A	A	C	C
NEMERTEA						TRICHOPTERA					
NEMATODA						*Orthopsyche*	A	-	-	-	-
NEMATOMORPHA						*Aoteapsyche*	R	A	C	A	A
ANNELIDA						Ecnomidae					
Oligochaeta	R	R	A	A	A	*Polyplectropus*					
Eiseniella						*Hydrobiosis*	-	C	-	C	C
Hirudinea						*Psilochorema*	R	-	-	-	-
MOLLUSCA						*Neurochorema*	R	-	C	-	-
Latia						*Costachorema*	R	C	C	A	C
Ferrissia						*Hydrochorema*					
Potamopyrgus	-	R	-	-	-	*Hydrobiosella*	C	-	-	-	-
Gyraulus						*Oxyethira*	-	-	C	C	C
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*	C	-	-	-	-
Sphaeriidae						*Beraeoptera*	A	A	A	-	R
Lymnaea						*Pycnocentrodes*					
CRUSTACEA						*Confluens*					
Copepoda	-	-	-	R	-	*Zelolessica*	R	-	-	-	-
Cladocera						*Olinga*	C	A	C	R	-
Ostracoda	-	-	-	-	R	*Helicopsyche*	R	C	-	R	-
Isopoda						*Triplectides*					
Paracalliope	-	-	-	-	C	*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	A	A	A	A	A
Nesameletus	R	A	C	R	-	*Zelandotipula*					
Coloburiscus	A	A	A	C	R	Eriopterini	R	R	-	-	-
Oniscigaster						Hexatomini					
Deleatidium	A	A	A	R	-	*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	R	R	C	R	R	Tanypodinae	-	R	-	-	-
Zephlebia group						*Maoridiamesa*	-	-	A	A	A
Acanthophlebia cruentata	R	-	-	-	-	Orthocladiinae	C	C	A	A	A
PLECOPTERA						Tanytarsini	-		R	A	C
Stenoperla	R	C	-	-	-	*Chironomus*					
Austroperla	C	-	-	-	-	*Polypedilum*					
Megaleptoperla	A	C	R	-	-	*Harrisius*	-	-	-	-	R
Zelandoperla	C	A	C	R	R	Ceratopogonidae					
Zelandobius	C	-	-	-	-	*Austrosimulium*	-	C	A	A	A
Acroperla						*Paradixa*					
A.spiniger	R	-	-	-	-	Empididae	-	-	C	C	A
Spaniocerca						Anthomyiidae	-	-	R	-	A
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae	-	-	R	-	-
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	-	-	R	R	-
Hydraenidae	C	A	C	C	-	Syrphidae					
Hydrophilidae						ACARINA	-	R	R	R	-
Elmidae	A	A	A	A	A	No of taxa	29	24	27	24	21
Staphylinidae						MCI	143	127	108	109	91
Dytiscidae	-	-	R	-	-	SQMCI	7.2	6.8	5.4	4.6	4.0
Ptilodactylidae						EPT	22	13	12	11	8.0
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Punehu Stream collected in a kick net on the 23 March 1998 in 3 Ring Plain stream sites.

SITE						SITE					
Site Code PNH000		210		800		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*		C		C	
NEMERTEA		-		R		TRICHOPTERA					
NEMATODA		-		R		*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*		A		A	
ANNELIDA						Ecnomidae					
Oligochaeta		A		A		*Polyplectropus*					
Eiseniella		-		R		*Hydrobiosis*		R		R	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*		R		-	
Ferrissia						*Hydrochorema*					
Potamopyrgus		C		R		*Hydrobiosella*					
Gyraulus						*Oxyethira*		C		A	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*		R		-	
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*		R		-	
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*		-		A	
Nesameletus		A		-		*Zelandotipula*					
Coloburiscus		C		-		Eriopterini		R		-	
Oniscigaster						Hexatomini					
Deleatidium		A		-		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima		R		-		Tanypodinae					
Zephlebia group						*Maoridiamesa*		C		R	
Acanthophlebia cruentata						Orthocladiinae		A		A	
PLECOPTERA						Tanytarsini					
Stenoperla		R		-		*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla		R		-		*Harrisius*					
Zelandoperla		C		-		Ceratopogonidae					
Zelandobius						*Austrosimulium*		R		R	
Acroperla						*Paradixa*					
A.spiniger						Empididae		-		R	
Spaniocerca						Anthomyiidae		-		A	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae		C		-		Syrphidae					
Hydrophilidae						ACARINA					
Elmidae		A		A		No of taxa		22		16	
Staphylinidae						MCI		123		74	
Dytiscidae						SQMCI		5.4		3.6	
Ptilodactylidae						EPT		13		3	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Stony River collected in a kick net on the 04 March (*) and the 10 March (^) 1998 in 3 Ring Plain stream sites.

SITE	^		^		*
Site Code STY000	260		280		400
COELENTERATA					
PLATYHELMINTHES					
Cura					
Neppia					
Rhabdocoela					
NEMERTEA					
NEMATODA					
NEMATOMORPHA					
ANNELIDA					
Oligochaeta	R		-		-
Eiseniella					
Hirudinea					
MOLLUSCA					
Latia					
Ferrissia					
Potamopyrgus					
Gyraulus					
Physa					
Physastra					
Sphaeriidae					
Lymnaea					
CRUSTACEA					
Copepoda					
Cladocera					
Ostracoda					
Isopoda					
Paranthura	R		-		-
Paralliope	-		R		-
Gammaridae					
Paratya					
Paranephrops					
EPHEMEROPTERA					
Ameletopsis					
Ichthybotus					
Nesameletus	R		-		-
Coloburiscus	R		-		-
Oniscigaster					
Deleatidium	XA		A		A
Mauiulus					
Austroclima					
Zephlebia group					
Acanthophlebia cruentata					
PLECOPTERA					
Stenoperla					
Austroperla	A		-		-
Megaleptoperla	R		-		-
Zelandoperla	A		-		C
Zelandobius					
Acroperla					
A.spiniger					
Spaniocerca					
ODONATA					
Austrolestes					
Xanthocnemis					
Ischnura					
Hemicordulia					
Antipodochlora					
COLEOPTERA					
Hydraenidae					
Hydrophilidae					
Elmidae	A		A		C
Staphylinidae					
Dytiscidae					
Ptilodactylidae					
Scritidae					

SITE					
HEMIPTERA					
Anisops					
Saldula					
Sigara					
Microvelia					
MEGALOPTERA					
Archichauliodes					
TRICHOPTERA					
Orthopsyche					
Aoteapsyche	C		-		R
Ecnomidae					
Polyplectropus					
Hydrobiosis					
Psilochorema					
Neurochorema					
Costachorema	C		R		C
Hydrochorema					
Hydrobiosella					
Oxyethira					
Paroxyethira	R		-		-
Pycnocentria					
Beraeoptera					
Pycnocentrodes					
Confluens					
Zelolessica					
Olinga					
Helicopsyche					
Triplectides					
Hudsonema					
Oeconesidae					
Oecetis					
LEPIDOPTERA					
Hygraula					
DIPTERA					
Limonia					
Aphrophila					
Zelandotipula					
Eriopterini	R		R		R
Hexatomini					
Paralimnophila					
Pedicia					
Tanypodinae					
Maoridiamesa					
Orthocladiinae	C		R		R
Tanytarsini					
Chironomus					
Polypedilum					
Harrisius					
Ceratopogonidae					
Austrosimulium					
Paradixa					
Empididae					
Anthomyiidae					
Psychodidae					
Culicidae					
Tabanidae					
Ephydridae					
Stratiomyidae					
Sciomyzidae					
Tanyderidae					
Syrphidae					
ACARINA					
No of taxa	14		6		7
MCI	117		110		114
SQMCI	6.4		6.4		6.7
EPT	9		2		4

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Te Popo Stream collected in a kick net on the 04 May 1998 in 1 Ring Plain stream site.

SITE						SITE					
Site Code TPP000	170					HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	C				
NEMERTEA						TRICHOPTERA					
NEMATODA						*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A				
ANNELIDA						Ecnomidae					
Oligochaeta	A					*Polyplectropus*					
Eiseniella						*Hydrobiosis*					
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*	R				
Latia						*Costachorema*	C				
Ferrissia						*Hydrochorema*					
Potamopyrgus						*Hydrobiosella*					
Gyraulus						*Oxyethira*	R				
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*	R				
CRUSTACEA						*Confluens*	R				
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*	R				
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	A				
Nesameletus	A					*Zelandotipula*					
Coloburiscus	A					Eriopterini	R				
Oniscigaster						Hexatomini					
Deleatidium	A					*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima						Tanypodinae					
Zephlebia group						*Maoridiamesa*	C				
Acanthophlebia cruentata						Orthocladiinae	A				
PLECOPTERA						Tanytarsini					
Stenoperla	R					*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla	R					*Harrisius*					
Zelandoperla	A					Ceratopogonidae					
Zelandobius						*Austrosimulium*	C				
Acroperla	R					*Paradixa*					
A.spiniger						Empididae	C				
Spaniocerca						Anthomyiidae					
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae	A					Syrphidae					
Hydrophilidae						ACARINA					
Elmidae	C					No of taxa	24				
Staphylinidae						MCI	111				
Dytiscidae						SQMCI	5.5				
Ptilodactylidae						EPT	14				
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Waiaua River collected in a kick net on the 17 February (*) and the 05 March (^) 1998 in 2 Ring Plain stream sites.

SITE		^		*		SITE					
Site Code WAA000		200		447		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*		R		-	
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*		C		C	
NEMERTEA		-		C		TRICHOPTERA					
NEMATODA		R		R		*Orthopsyche*		R		-	
NEMATOMORPHA						*Aoteapsyche*		C		A	
ANNELIDA						Ecnomidae					
Oligochaeta		-		A		*Polyplectropus*					
Eiseniella						*Hydrobiosis*		C		C	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*		R		-	
Latia						*Costachorema*					
Ferrissia						*Hydrochorema*					
Potamopyrgus						*Hydrobiosella*					
Gyraulus						*Oxyethira*		-		A	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*		R		-	
Lymnaea						*Pycnocentrodes*		-		R	
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*		R		C	
Nesameletus		C		-		*Zelandotipula*					
Coloburiscus		C		R		Eriopterini		A		R	
Oniscigaster						Hexatomini					
Deleatidium		XA		C		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima						Tanypodinae					
Zephlebia group						*Maoridiamesa*		-		A	
Acanthophlebia cruentata						Orthocladiinae		C		A	
PLECOPTERA						Tanytarsini		-		C	
Stenoperla		R		-		*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla		-		R		*Harrisius*					
Zelandoperla		R		R		Ceratopogonidae					
Zelandobius						*Austrosimulium*		-		C	
Acroperla						*Paradixa*					
A.spiniger						Empididae		R		-	
Spaniocerca						Anthomyiidae		-		R	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae		R		-		Syrphidae					
Hydrophilidae						ACARINA					
Elmidae		A		A		No of taxa		20		20	
Staphylinidae						MCI		119		92	
Dytiscidae						SQMCI		5.8		4.0	
Ptilodactylidae						EPT		10		8	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa),\ XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Waiongana Stream collected in a kick net on the 25 March 1998 in 4 Ring Plain stream sites.

SITE						SITE					
Site Code	WGA000	120	170	260	360	HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura		-	-	C		*Microvelia*					
Neppia		R				MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	A	C	A	R	
NEMERTEA		-	-	C	A	TRICHOPTERA					
NEMATODA		-	-	C	-	*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A	A	C	-	
ANNELIDA						Ecnomidae					
Oligochaeta		A	A	A	A	*Polyplectropus*					
Eiseniella				R	-	*Hydrobiosis*	C	-	R	-	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*	R	R	-	-	
Latia						*Costachorema*	C	-	R	-	
Ferrissia						*Hydrochorema*					
Potamopyrgus		R	-	R	A	*Hydrobiosella*					
Gyraulus						*Oxyethira*	-	A	A	A	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*	R	-	-	-	
Sphaeriidae						*Beraeoptera*	A	-	-	-	
Lymnaea						*Pycnocentrodes*	R	R	R	-	
CRUSTACEA						*Confluens*	R	-	-	-	
Copepoda						*Zelolessica*	R	-	-	-	
Cladocera						*Olinga*	C	-	-	-	
Ostracoda						*Helicopsyche*	A	-	-	-	
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae	R	-	-	-	
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus		R	-	-	-	*Aphrophila*	A	A	A	C	
Nesameletus		A	R	-	-	*Zelandotipula*					
Coloburiscus		A	C	R	-	Eriopterini	R	R	-	-	
Oniscigaster						Hexatomini					
Deleatidium		A	R	C	-	*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima		C	R	-	-	Tanypodinae	R	-	-	-	
Zephlebia group						*Maoridiamesa*	-	A	R	-	
Acanthophlebia cruentata						Orthocladiinae	A	A	A	A	
PLECOPTERA						Tanytarsini	-	C	C	-	
Stenoperla		C	-	-	-	*Chironomus*					
Austroperla		C	-	-	-	*Polypedilum*					
Megaleptoperla		C	-	-	-	*Harrisius*					
Zelandoperla		A	C	-	-	Ceratopogonidae					
Zelandobius		R	-	R	-	*Austrosimulium*	R	C	C	-	
Acroperla						*Paradixa*					
A.spiniger						Empididae	-	R	A	R	
Spaniocerca						Anthomyiidae	-	R	A	R	
ODONATA						Psychodidae	C	-	-	-	
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	-	-	R	-	
Hydraenidae		A	C	-	-	Syrphidae					
Hydrophilidae		R	-	-	-	ACARINA	-	R	R	R	
Elmidae		A	A	A	R	No of taxa	36	22	26	11	
Staphylinidae						MCI	124	100	88	75	
Dytiscidae						SQMCI	6.5	4.4	3.9	3	
Ptilodactylidae		R	-	R	-	EPT	22	9	8	9	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Waingongoro River collected in a kick net on the 19 March 1998 in 6 Ring Plain stream sites.

SITE						SITE					
Site Code WGG000	150		490		550	HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia	R		-		-	MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	A		C		C
NEMERTEA	-		R		C	TRICHOPTERA					
NEMATODA	-		R		R	*Orthopsyche*	R		-		-
NEMATOMORPHA						*Aoteapsyche*	A		A		C
ANNELIDA						Ecnomidae					
Oligochaeta	-		A		C	*Polyplectropus*					
Eiseniella	-		-		R	*Hydrobiosis*	C		R		R
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*	R		R		-
Ferrissia						*Hydrochorema*					
Potamopyrgus	R		R		A	*Hydrobiosella*					
Gyraulus						*Oxyethira*	-		A		C
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*	R		-		-
Sphaeriidae						*Beraeoptera*	A		-		-
Lymnaea						*Pycnocentrodes*	C		R		C
CRUSTACEA						*Allocentrella*	R		-		-
Copepoda						*Zelolessica*					
Cladocera						*Olinga*	A		-		-
Ostracoda						*Helicopsyche*	C		-		-
Isopoda						*Triplectides*	-		R		-
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	A		R		C
Nesameletus	A		-		-	*Zelandotipula*					
Coloburiscus	A		-		-	Eriopterini	R		-		R
Oniscigaster						Hexatomini					
Deleatidium	A		-		-	*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	A		R		C	Tanypodinae					
Zephlebia group	R		-		-	*Maoridiamesa*	R		-		-
Acanthophlebia cruentata						Orthocladiinae	A		A		C
PLECOPTERA						Tanytarsini	-		C		A
Stenoperla						*Chironomus*					
Austroperla	R		-		-	*Polypedilum*					
Megaleptoperla	R		-		-	*Harrisius*					
Zelandoperla	A		R		-	Ceratopogonidae					
Zelandobius						*Austrosimulium*	R		C		R
Acroperla						*Paradixa*					
A.spiniger						Empididae	-		R		R
Spaniocerca						Anthomyiidae	-		R		-
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	-		R		R
Hydraenidae	A		-		-	Syrphidae					
Hydrophilidae						ACARINA	-		R		R
Elmidae	A		A		A	No of taxa	28		22		20
Staphylinidae						MCI	132		86		82
Dytiscidae						SQMCI	6.7		3.8		4.1
Ptilodactylidae						EPT	18		8		5
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Waingongoro River collected in a kick net on the 20 March1998 in 6 Ring Plain stream sites.

SITE						SITE					
Site Code WGG000	680		778		895	HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura	-		R		R	*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	A		-		C
NEMERTEA	A		-		C	TRICHOPTERA					
NEMATODA	R		R		-	*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A		A		A
ANNELIDA						Ecnomidae					
Oligochaeta	A		A		C	*Polyplectropus*					
Eiseniella	R		C		-	*Hydrobiosis*	R		R		-
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia	-		-		R	*Costachorema*	R		R		-
Ferrissia						*Hydrochorema*					
Potamopyrgus	A		A		A	*Hydrobiosella*					
Gyraulus						*Oxyethira*	C		R		-
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*	-		-		R
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*	-		C		A
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*					
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope	R		R		R	*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*	A		R		R
Nesameletus						*Zelandotipula*					
Coloburiscus						Eriopterini	-		R		-
Oniscigaster						Hexatomini					
Deleatidium						*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	R		-		-	Tanypodinae					
Zephlebia group						*Maoridiamesa*					
Acanthophlebia cruentata						Orthocladiinae	A		C		R
PLECOPTERA						Tanytarsini	C		-		R
Stenoperla						*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla						*Harrisius*					
Zelandoperla						Ceratopogonidae					
Zelandobius						*Austrosimulium*	C		R		R
Acroperla						*Paradixa*					
A.spiniger						Empididae	R		-		R
Spaniocerca						Anthomyiidae					
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae	-		R		R
Ischnura						Ephydridae	-		R		-
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	C		-		R
Hydraenidae	R		R		-	Syrphidae					
Hydrophilidae						ACARINA	R		-		-
Elmidae	A		A		A	No of taxa	21		19		18
Staphylinidae						MCI	88		84		81
Dytiscidae						SQMCI	4.0		4.0		4.3
Ptilodactylidae						EPT	5		5		3
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Waiwakaiho River collected in a kick net on the 08 April (*), 17 April (^) and the 19 April (#) 1998 in 4 Ring Plain stream sites.

SITE	^	*	#	#		SITE					
Site Code WKH000	185	475	687	860		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*	C	A	C	C	
NEMERTEA	-	-	C	R		TRICHOPTERA					
NEMATODA	-	R	C	A		*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*	A	A	C	C	
ANNELIDA						Ecnomidae					
Oligochaeta	R	C	A	A		*Polyplectropus*	-	-	-	R	
Eiseniella						*Hydrobiosis*	-	R	C	R	
Hirudinea						*Psilochorema*	-	R	-	-	
MOLLUSCA						*Neurochorema*	-	C	-	-	
Latia						*Costachorema*	C	A	-	-	
Ferrissia						*Hydrochorema*					
Potamopyrgus	-	-	R	C		*Hydrobiosella*					
Gyraulus						*Oxyethira*	-	R	A	A	
Physa	-	-	R	-		*Paroxyethira*					
Physastra						*Pycnocentria*	R	R	-	-	
Sphaeriidae						*Beraeoptera*	A	A	-	-	
Lymnaea						*Pycnocentrodes*	R	C	-	-	
CRUSTACEA						*Confluens*	R	R	-	-	
Copepoda						*Allocentrella*	R	-	-	-	
Cladocera						*Olinga*	-	R	-	-	
Ostracoda						*Helicopsyche*	A	R	-	-	
Isopoda						*Triplectides*					
Paracalliope						*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus	-	R	-	-		*Aphrophila*	A	A	A	C	
Nesameletus	A	A	-	-		*Zelandotipula*					
Coloburiscus	A	A	-	-		Eriopterini	C	R	-	R	
Oniscigaster						Hexatomini					
Deleatidium	A	A	-	-		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima	A	C	-	-		Tanypodinae	R	-	-	-	
Zephlebia group						*Maoridiamesa*	-	R	A	R	
Acanthophlebia cruentata						Orthocladiinae	A	A	A	A	
PLECOPTERA						Tanytarsini	-	-	A	A	
Stenoperla	C	-	-	-		*Chironomus*					
Austroperla	R	-				*Polypedilum*					
Megaleptoperla	A	C	R	-		*Harrisius*					
Zelandoperla	A	A				Ceratopogonidae					
Zelandobius	C	-	R	-		*Austrosimulium*	-	R	A	C	
Acroperla						*Paradixa*					
A.spiniger						Empididae	-	R	A	C	
Spaniocerca						Anthomyiidae	-	C	A	C	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae	-	-	R	R	
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae	-	R	-	R	
Hydraenidae	C	-	R	-		Syrphidae					
Hydrophilidae						ACARINA	-	-	R	-	
Elmidae	A	A	A	C		No of taxa	25	31	22	21	
Staphylinidae						MCI	132	113	83	80	
Dytiscidae						SQMCI	6.8	6	3.6	3.5	
Ptilodactylidae	-	-	-	R		EPT	17	19	5	4	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa) XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Warea River collected in a kick net on the 22 April 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code WRE000		150		450		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*		-		R	
Cura		-		R		*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*		A		R	
NEMERTEA		R		A		TRICHOPTERA					
NEMATODA		R		R		*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*		C		-	
ANNELIDA						Ecnomidae					
Oligochaeta		A		A		*Polyplectropus*					
Eiseniella						*Hydrobiosis*		C		-	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia						*Costachorema*					
Ferrissia						*Hydrochorema*					
Potamopyrgus		R		C		*Hydrobiosella*					
Gyraulus						*Oxyethira*		A		A	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*		R		-	
CRUSTACEA						*Confluens*					
Copepoda						*Zelolessica*					
Cladocera						*Olinga*		C		-	
Ostracoda						*Helicopsyche*					
Isopoda						*Triplectides*					
Paracalliope		-		A		*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*		A		C	
Nesameletus		R		-		*Zelandotipula*					
Coloburiscus		A		-		Eriopterini		R		-	
Oniscigaster						Hexatomini					
Deleatidium						*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima						Tanypodinae					
Zephlebia group						*Maoridiamesa*		A		C	
Acanthophlebia cruentata						Orthocladiinae		A		A	
PLECOPTERA						Tanytarsini		C		-	
Stenoperla		R		-		*Chironomus*					
Austroperla		R		-		*Polypedilum*					
Megaleptoperla		R		-		*Harrisius*					
Zelandoperla		R		-		Ceratopogonidae					
Zelandobius						*Austrosimulium*		A		C	
Acroperla						*Paradixa*					
A.spiniger						Empididae		R		R	
Spaniocerca						Anthomyiidae		A		A	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae		R		-		Syrphidae					
Hydrophilidae						ACARINA					
Elmidae		A		C		No of taxa		26		16	
Staphylinidae						MCI		105		70	
Dytiscidae						SQMCI		4.5		3.2	
Ptilodactylidae						EPT		11		1	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Waitara River collected in a kick net on the 09 March 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code WTR000		800		890		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura		-		R		*Microvelia*					
Neppia						MEGALOPTERA					
Rhabdocoela						*Archichauliodes*		C		-	
NEMERTEA		R		-		TRICHOPTERA					
NEMATODA		-		A		*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*		A		-	
ANNELIDA						Ecnomidae					
Oligochaeta		A		A		*Polyplectropus*					
Eiseniella						*Hydrobiosis*					
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*					
Latia		A		-		*Costachorema*					
Ferrissia						*Hydrochorema*					
Potamopyrgus		A		A		*Hydrobiosella*					
Melanopsis		-		R		*Oxyethira*		C		R	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*					
Lymnaea						*Pycnocentrodes*					
CRUSTACEA						*Confluens*					
Helice		-		C		*Zelolessica*					
Corophiiae		-		A		*Olinga*					
Ostracoda						*Helicopsyche*					
Isopoda		-		R		*Triplectides*					
Paracalliope						*Hudsonema*					
Paranthura		-		C		Oeconesidae					
Gammaridae						*Oecetis*					
Paratya		R		A		LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*		A		R	
Nesameletus						*Zelandotipula*					
Coloburiscus						Eriopterini					
Oniscigaster						Hexatomini					
Deleatidium						*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima						Tanypodinae					
Zephlebia group						*Maoridiamesa*		R		-	
Acanthophlebia cruentata						Orthocladiinae		A		A	
PLECOPTERA						Tanytarsini		A		-	
Stenoperla						*Chironomus*					
Austroperla						*Polypedilum*					
Megaleptoperla						*Harrisius*					
Zelandoperla						Ceratopogonidae					
Zelandobius						*Austrosimulium*		R		-	
Acroperla						*Paradixa*					
A.spiniger						Empididae		C		R	
Spaniocerca						Anthomyiidae		R		R	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae						Syrphidae					
Hydrophilidae						ACARINA					
Elmidae		C		C		No of taxa		17		16	
Staphylinidae						MCI		76		70	
Dytiscidae						SQMCI		3.7		3.3	
Ptilodactylidae		R		-		EPT		2		1	
Scritidae											

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Macroinvertebrate fauna of the Waiweranui Stream collected in a kick net on the 14 April 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code WWN		200		900		HEMIPTERA					
						Anisops					
COELENTERATA						*Saldula*					
PLATYHELMINTHES						*Sigara*					
Cura						*Microvelia*					
Neppia		R		-		MEGALOPTERA					
Rhabdocoela						*Archichauliodes*		A		C	
NEMERTEA		-		A		TRICHOPTERA					
NEMATODA		-		C		*Orthopsyche*					
NEMATOMORPHA						*Aoteapsyche*		A		R	
ANNELIDA						Ecnomidae					
Oligochaeta		C		A		*Polyplectropus*					
Eiseniella						*Hydrobiosis*		C		-	
Hirudinea						*Psilochorema*					
MOLLUSCA						*Neurochorema*		R		-	
Latia						*Costachorema*		A		-	
Ferrissia						*Hydrochorema*					
Potamopyrgus		C		A		*Hydrobiosella*					
Gyraulus						*Oxyethira*		R		A	
Physa						*Paroxyethira*					
Physastra						*Pycnocentria*					
Sphaeriidae						*Beraeoptera*		A		-	
Lymnaea						*Pycnocentrodes*		A		-	
CRUSTACEA						*Confluens*		R		-	
Copepoda						*Zelolessica*		C		-	
Cladocera						*Olinga*		C		-	
Ostracoda						*Helicopsyche*		R		-	
Isopoda						*Pycocentrella*		R		-	
Paracalliope		-		C		*Hudsonema*					
Paraleptamphopus						Oeconesidae					
Gammaridae						*Oecetis*					
Paratya						LEPIDOPTERA					
Paranephrops						*Hygraula*					
EPHEMEROPTERA						DIPTERA					
Ameletopsis						*Limonia*					
Ichthybotus						*Aphrophila*		A		C	
Nesameletus		C		-		*Zelandotipula*					
Coloburiscus		A		-		Eriopterini		C		-	
Oniscigaster						Hexatomini					
Deleatidium		A		-		*Paralimnophila*					
Mauiulus						*Pedicia*					
Austroclima		A		-		Tanypodinae					
Zephlebia group						*Maoridiamesa*		C		C	
Acanthophlebia cruentata						Orthocladiinae		A		A	
PLECOPTERA						Tanytarsini		C		-	
Stenoperla		R		-		*Chironomus*					
Austroperla		R		-		*Polypedilum*					
Megaleptoperla		C		-		*Harrisius*					
Zelandoperla		R		-		Ceratopogonidae					
Zelandobius		R		-		*Austrosimulium*		C		C	
Acroperla						*Paradixa*					
A.spiniger						Empididae		R		C	
Spaniocerca						Anthomyiidae		R		A	
ODONATA						Psychodidae					
Austrolestes						Culicidae					
Xanthocnemis						Tabanidae					
Ischnura						Ephydridae					
Hemicordulia						Stratiomyidae					
Antipodochlora						Sciomyzidae					
COLEOPTERA						Tanyderidae					
Hydraenidae		C		-		Syrphidae					
Hydrophilidae						ACARINA		R		-	
Elmidae		A		A		No of taxa		37		15	
Staphylinidae						MCI		119		73	
Dytiscidae						SQMCI		5.9		3.4	
Ptilodactylidae						EPT		21		2	
Scritidae		R		-							

R = Rare (0-5 taxa), C = Common (6-19 taxa), A = Abundant (20-499 taxa), XA = Extra Abundant (≥500 taxa).

Benthic microflora of the Inaha Stream collected in a kick net on the 25 (#), 26 March (^) and the 05 (*), 06 (>) May* 1998 in 5 Ring Plain sites.

SITE	*	^	^	#	>	SITE					
Site Code INH000	120	125	430	470	473	**CYANOBACTERIA** – Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*	P	-	P	-	-
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus	-	P	P	-	-	*Nostoc*					
Closterium						*Tolypothrix*					
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*					
Tetraedron						*Microcoleus*					
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*					
Polyedriopsis						*Chamaesiphon*					
Chodatella						**DIATOMS (Unicellular)** - Unknown					
Euastrum						*Synedra*	P	P	P	P	P
Cosmarium						*Nitzschia*	P	P	P	-	P
Micrasterias						*Navicula*	P	P	P	-	P
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*					
Carteria						*Cymbella*					
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*	P	P	P	-	-
(Colonial) – Unidentified						*Rhoicosphenia*	P	-	P	-	A
Coelastrum						*Pinnularia*	-	-	P	P	-
Botryococcus						*Cocconeis*	P	-	P	-	A
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*					
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*					
Micractinium						*Achnanthes*	-	P	-	P	P
Scenedesmus	-	-	P	-	-	*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*	-	P	-	-	-
Volvox						*Diatoma*					
Pandorina						*Melosira*	-	-	P	P	P
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha						*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) – Unidentified						**RHODOPHYTES**					
Oedogonium	-	-	P	-	P	*Bostrychia*					
Ulothrix						*Batrachospermum*					
Klebsormidium						*Audouinella*	-	-	P	-	-
Spirogyra						*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora	-	A	P	-	-	**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) – Unidentified						*Phacus*					
Cladophora	-	A	P	P	P	**CRYPTOPHYTES** - *Cryptomonas*					
Chaetophora											
Stigeoclonium	-	-	-	P	-	**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*	P	P	P	-	-
Parellela						*Fungi*	-	-	P	-	-
Charophytes						*Protozoa*	-	-	P	P	P
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA	8	10	18	7	10

= Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Kahouri Stream collected in a kick net on the 16 (*), 10 March (^) and the 19 March (#) 1988 in 4 Ring Plain stream sites

SITE						SITE					
Site Code KHI000	260	300	400	480		**BLUE GREEN ALGAE** – Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*		P	P	A	
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus	-	P	-	-	-	*Nostoc*					
Closterium	-	P	-	-	-	*Tolypothrix*				P	
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*	P			P	
Tetraedron						*Microcoleus*				P	
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*			P		
Polyedriopsis						*Chamaesiphon*		P			
Chodatella						**DIATOMS (Unicellular)** - Unknown					
Euastrum						*Synedra*	P	P	P	P	
Cosmarium						*Nitzschia*	P	P	P	P	
Micrasterias						*Navicula*	P	P	P		
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*					
Carteria						*Cymbella*	P		P	P	
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*	P	P	P	P	
(Colonial) – Unidentified						*Rhoicosphenia*				P	
Coelastrum						*Pinnularia*					
Botryococcus						*Cocconeis*		P		P	
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*				P	
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*					
Micractinium						*Achnanthes*	P		P	P	
Scenedesmus						*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*					
Volvox						*Diatoma*					
Pandorina						*Melosira*			P	P	
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha						*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) – Unidentified						**RHODOPHYTES**					
Oedogonium	-	P	A	P		*Bostrychia*					
Ulothrix						*Batrachospermum*	P		P	P	
Klebsormidium						*Audouinella*				P	
Spirogyra	A	-	A	P		*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** – *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) – Unidentified						*Phacus*					
Cladophora	-	P	-	P		**CRYPTOPHYTES** – *Cryptomonas*					
Chaetophora											
Stigeoclonium						**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*	P	-	-	P	
Parellela						*Fungi*	-	P	-	-	
Charophytes						*Protozoa*	P	-	P	P	
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA	11	12	13	20	

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Kapoaiaia Stream collected in a kick net on 23 March and the 06 May (^) 1998 in 4 Ring Plain stream sites.

SITE	*	*	^	*		SITE					
Site Code KPA000	250	745	755	760		**BLUE GREEN ALGAE** - Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*	P	P	P	P	
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus	P	P	P	P		*Nostoc*	P	-	-	-	
Closterium						*Tolypothrix*					
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*	P	P	P	P	
Tetraedron						*Microcoleus*	P	P	-	P	
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*	-	P	P	P	
Polyedriopsis						*Chamaesiphon*	-	-	P	P	
Chodatella						**DIATOMS (Unicellular)** - Unknown					
Euastrum						*Synedra*	P	A	P	A	
Cosmarium						*Nitzschia*	P	P	P	P	
Micrasterias						*Navicula*	P	P	P	P	
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*					
Carteria						*Cymbella*	A	P	P	P	
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*	A	P	P	A	
(Colonial) - Unidentified						*Rhoicosphenia*	P	P	P	P	
Coelastrum						*Pinnularia*	-	-	P	-	
Botryococcus						*Cocconeis*	-	P	P	P	
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*					
Kirchneriella						*Epithemia*	A	P	P	P	
Sphaerocystis						*Eunotia*					
Gloeocystis	-	P	-	-		*Eunotia serpentina*					
Golenkinia						*Surirella*	P	-	-	-	
Micractinium						*Achnanthes*	P	P	-	P	
Scenedesmus	-	P	-	P		*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*	P	-	-	-	
Volvox						*Diatoma*					
Pandorina						*Melosira*	P	P	P	P	
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha						*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) - Unidentified						**RHODOPHYTES**					
Oedogonium	P	P	-	P		*Bostrychia*	-	-	P	-	
Ulothrix						*Batrachospermum*					
Klebsormidium						*Audouinella*					
Spirogyra	P	-	-	P		*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) – Unidentified						*Phacus*					
Cladophora	P	P	P	P		**CRYPTOPHYTES** - *Cryptomonas*					
Chaetophora											
Stigeoclonium	P	-	-	-		**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*	P	P	P	P	
Parellela						*Fungi*	-	P	P	P	
Charophytes						*Protozoa*	P	P	-	P	
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA	22	22	19	23	

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Kaupokonui River collected in akick net on the 24 March 1998 in 7 Ring Plain stream sites

SITE						SITE					
Site Code	KPK000	250	500	520	550		**CYANOBACTERIA** – Unidentified					
							Anabaena					
GREEN ALGAE (Unicellular)							*Oscillatoria*	P	P	P	P	
Unidentified (nannoplankton)							*Microcystis*					
Ankistrodesmus		P	-	-	P		*Nostoc*					
Closterium							*Tolypothrix*					
Chlorella							*Spirulina*					
Oocystis							*Stigonema*					
Staurastrum							*Lyngbya*	P	-	-	P	
Tetraedron							*Microcoleus*					
Chlamydomonas							*Scytonema*					
Selenastrum							*Phormidium*					
Polyedriopsis							*Chamaesiphon*					
Chodatella							**DIATOMS (Unicellular)** - Unknown	P	P	P	P	
Euastrum							*Synedra*	P	A	P	P	
Cosmarium							*Nitzschia*	P	P	-	P	
Micrasterias							*Navicula*	P	P	A	P	
Diacanthos							*Hanzschia*					
Characium							*Stauroneis*					
Netrium							*Gyrosigma*					
Carteria							*Cymbella*	P	P	P	P	
Haematococcus							*Rhopalodia*					
Arthrodesmus							*Gomphonema/Gomphenemis*	P	A	A	P	
(Colonial) - Unidentified							*Rhoicosphenia*	P	-	-	-	
Coelastrum							*Pinnularia*					
Botryococcus							*Cocconeis*					
Planktosphaeria							*Diploneis*					
Dictyosphaerium							*Cyclotella*					
Kirchneriella							*Epithemia*					
Sphaerocystis							*Eunotia*					
Gloeocystis							*Eunotia serpentina*					
Golenkinia							*Surirella*	-	P	-	-	
Micractinium							*Achnanthes*					
Scenedesmus							*Fragilaria*					
Pediastrum							*Asterionella*					
Actinastrum							*Tabellaria*					
Volvox							*Diatoma*					
Pandorina							*Melosira*	-	P	P	P	
Eudorina							**GOLDEN BROWN ALGAE**					
Tetraspora							*Dinobryon*					
Enteromorpha							*Mallomonas*					
Ulva							*Synura*					
(Unbranched filaments) - Unidentified							**RHODOPHYTES**					
Oedogonium		-	P	P	P		*Bostrychia*					
Ulothrix		-	P	-	-		*Batrachospermum*					
Klebsormidium							*Audouinella*					
Spirogyra		-	P	P	P		*Chroodactylon*					
Spondylosium							*Compsopogon*					
Hyalotheca							*Boldia*					
Desmidium							**DINOFLAGELLATES** - *Peridinium* group					
Microspora							**EUGLENOIDS**					
Mougeotia							*Trachelomonas*					
Zygnema							*Euglena*					
(Branched filaments) - Unidentified							*Phacus*					
Cladophora		P	-	P	P		**CRYPTOPHYTES** – *Cryptomonas*					
Chaetophora												
Stigeoclonium		-	A	A	A		**NON-ALGAL GROUPS:**					
Draparnaldia							*Non-pigmented filamentous bacteria*	P	P	P	P	
Parellela							*Fungi*	P	P	P	-	
Charophytes							*Protozoa*	P	-	-	-	
YELLOW GREEN ALGAE												
Tribonema												
Vaucheria							NUMBER OF TAXA	14	15	13	15	

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥ 75% of slide).

Benthic microflora of the Kaupokonui River collected in a kick net on the 24 March (*) and the 06 May (^) 1998 in 7 Ring Plain stream sites.

SITE	*		*		^
Site Code KPK000	685		880		900
GREEN ALGAE (Unicellular)					
Unidentified (nannoplankton)					
Ankistrodesmus	-		-		A
Closterium					
Chlorella					
Oocystis					
Staurastrum					
Tetraedron					
Chlamydomonas					
Selenastrum					
Polyedriopsis					
Chodatella					
Euastrum					
Cosmarium					
Micrasterias					
Diacanthos					
Characium					
Netrium					
Carteria					
Haematococcus					
Arthrodesmus					
(Colonial) - Unidentified					
Coelastrum					
Botryococcus					
Planktosphaeria					
Dictyosphaerium					
Kirchneriella					
Sphaerocystis					
Gloeocystis	-		-		P
Golenkinia					
Micractinium					
Scenedesmus	-		-		P
Pediastrum					
Actinastrum					
Volvox					
Pandorina					
Eudorina					
Tetraspora					
Enteromorpha					
Ulva					
(Unbranched filaments) - Unidentified					
Oedogonium	P		P		P
Ulothrix					
Klebsormidium					
Spirogyra	-		-		P
Spondylosium					
Hyalotheca					
Desmidium					
Microspora					
Mougeotia					
Zygnema					
(Branched filaments) - Unidentified					
Cladophora	P		-		A
Chaetophora					
Stigeoclonium	A		A		-
Draparnaldia					
Parellela					
Charophytes					
YELLOW GREEN ALGAE					
Tribonema					
Vaucheria					

SITE					
CYANOBACTERIA - Unidentified					
Anabaena					
Oscillatoria	-		P		P
Microcystis					
Nostoc					
Tolypothrix					
Spirulina					
Stigonema					
Lyngbya					
Microcoleus	-		-		P
Scytonema					
Phormidium					
Chamaesiphon	-		-		A
DIATOMS (Unicellular) - Unknown					
Synedra	-		P		P
Nitzschia	P		-		P
Navicula	A		P		P
Hanzschia					
Stauroneis					
Gyrosigma					
Cymbella	P		P		P
Rhopalodia					
Gomphonema/Gomphenemis	-		P		P
Rhoicosphenia	A		-		P
Pinnularia	-		-		P
Cocconeis	-		-		A
Diploneis					
Cyclotella					
Epithemia					
Eunotia					
Eunotia serpentina					
Surirella					
Achnanthes	-		-		A
Fragilaria					
Asterionella					
Tabellaria					
Diatoma	-		-		P
Melosira	P		P		P
GOLDEN BROWN ALGAE					
Dinobryon					
Mallomonas					
Synura					
RHODOPHYTES					
Bostrychia					
Batrachospermum					
Audouinella					
Chroodactylon					
Compsopogon					
Boldia					
DINOFLAGELLATES - *Peridinium* group					
EUGLENOIDS					
Trachelomonas					
Euglena					
Phacus					
CRYPTOPHYTES - *Cryptomonas*					
NON-ALGAL GROUPS:					
Non-pigmented filamentous bacteria	-		P		P
Fungi					
Protozoa	-		-		P
NUMBER OF TAXA	8		9		22

P = Present A = Abundant (50% of slides), VA = Very abundant (75% of slide).

Benthic microflora of the Manganui River collected in a kick net on the 23 (*), 26 (^) March and the 06 May (#) 1998 in 3 Ring Plain stream sites

SITE	*		#		^
Site Code MGN000	150		300		320
GREEN ALGAE (Unicellular)					
Unidentified (nannoplankton)					
Ankistrodesmus	-		P		P
Closterium	-		-		P
Chlorella					
Oocystis					
Staurastrum					
Tetraedron					
Chlamydomonas					
Selenastrum					
Polyedriopsis					
Chodatella					
Euastrum					
Cosmarium					
Micrasterias					
Diacanthos					
Characium					
Netrium					
Carteria					
Haematococcus					
Arthrodesmus					
(Colonial) – Unidentified					
Coelastrum					
Botryococcus					
Planktosphaeria					
Dictyosphaerium					
Kirchneriella					
Sphaerocystis					
Gloeocystis	-		-		P
Golenkinia					
Micractinium					
Scenedesmus					
Pediastrum					
Actinastrum					
Volvox					
Pandorina					
Eudorina					
Tetraspora					
Enteromorpha					
Ulva					
(Unbranched filaments) – Unidentified					
Oedogonium	-		P		P
Ulothrix	-		P		-
Klebsormidium					
Spirogyra					
Spondylosium					
Hyalotheca					
Desmidium					
Microspora					
Mougeotia					
Zygnema					
(Branched filaments) – Unidentified					
Cladophora	-		P		-
Chaetophora					
Stigeoclonium	-		P		P
Draparnaldia					
Parellela					
Charophytes					
YELLOW GREEN ALGAE					
Tribonema					
Vaucheria					

SITE					
CYANOBACTERIA - Unidentified					
Anabaena					
Oscillatoria	P		P		P
Microcystis					
Nostoc					
Tolypothrix					
Spirulina					
Stigonema					
Lyngbya	-		P		P
Microcoleus					
Scytonema					
Phormidium	P		P		P
Chamaesiphon	-		P		-
DIATOMS (Unicellular) - Unknown	-		P		P
Synedra	-		P		P
Nitzschia	P		P		A
Navicula	-		P		P
Hanzschia					
Stauroneis					
Gyrosigma					
Cymbella	-		P		P
Rhopalodia					
Gomphonema/Gomphenemis	-		A		P
Rhoicosphenia	-		P		-
Pinnularia					
Cocconeis					
Diploneis					
Cyclotella	-		P		-
Epithemia					
Eunotia	-		P		P
Eunotia serpentina					
Surirella					
Achnanthes	-		P		-
Fragilaria					
Asterionella					
Tabellaria					
Diatoma					
Melosira	-		P		P
GOLDEN BROWN ALGAE					
Dinobryon					
Mallomonas					
Synura					
RHODOPHYTES					
Bostrychia					
Batrachospermum					
Audouinella					
Chroodactylon					
Compsopogon					
Boldia					
DINOFLAGELLATES - *Peridinium* group					
EUGLENOIDS					
Trachelomonas					
Euglena					
Phacus					
CRYPTOPHYTES - *Cryptomonas*					
NON-ALGAL GROUPS:					
Non-pigmented filamentous bacteria	-		P		-
Fungi	-		P		P
Protozoa	P		P		P
NUMBER OF TAXA	4		23		18

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Mangahume Stream collected in a kick net on the 05 March 1998 in 3 Ring Plain stream sites.

SITE						SITE					
Site Code MHM000	300		650		970	**CYANOBACTERIA** – Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*	-		-		P
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus						*Nostoc*					
Closterium						*Tolypothrix*					
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*	-		-		P
Tetraedron						*Microcoleus*					
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*					
Polyedriopsis						*Chamaesiphon*					
Chodatella						**DIATOMS (Unicellular)** - Unknown					
Euastrum						*Synedra*	-		P		A
Cosmarium						*Nitzschia*	-		P		P
Micrasterias						*Navicula*	-		-		P
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*	-		-		P
Carteria						*Cymbella*	-		-		P
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*	-		-		P
(Colonial) - Unidentified						*Rhoicosphenia*	-		-		P
Coelastrum						*Pinnularia*					
Botryococcus						*Cocconeis*	-		P		P
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*	-		-		P
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*					
Micractinium						*Achnanthes*	-		P		A
Scenedesmus						*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*					
Volvox						*Diatoma*					
Pandorina						*Melosira*	P		-		P
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha						*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) - Unidentified						**RHODOPHYTES**					
Oedogonium	P		-		P	*Bostrychia*					
Ulothrix						*Batrachospermum*					
Klebsormidium						*Audouinella*					
Spirogyra	P		-		-	*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*	-		P		-
(Branched filaments) - Unidentified						*Phacus*					
Cladophora	-		P		P	**CRYPTOPHYTES** - *Cryptomonas*					
Chaetophora											
Stigeoclonium	-		-		A	**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*	P		-		-
Parellela						*Fungi*	-		P		P
Charophytes						*Protozoa*	-		P		-
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA	4		8		17

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Maketawa Stream collected in a kick net on the 06 March 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code MKW000		200		250		CYANOBACTERIA - Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*		P		P	
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus						*Nostoc*					
Closterium						*Tolypothrix*					
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*		P		P	
Tetraedron						*Microcoleus*					
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*		-		P	
Polyedriopsis						*Chamaesiphon*		-		A	
Chodatella						**DIATOMS (Unicellular)** - Unknown					
Euastrum						*Synedra*		P		P	
Cosmarium						*Nitzschia*		P		P	
Micrasterias						*Navicula*		-		P	
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*					
Carteria						*Cymbella*		-		P	
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*		P		A	
(Colonial) - Unidentified						*Rhoicosphenia*		P		P	
Coelastrum						*Pinnularia*					
Botryococcus						*Cocconeis*					
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*					
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*					
Micractinium						*Achnanthes*		P		P	
Scenedesmus						*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*					
Volvox						*Diatoma*					
Pandorina						*Melosira*		-		P	
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha						*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) - Unidentified						**RHODOPHYTES**					
Oedogonium		-		P		*Bostrychia*					
Ulothrix						*Batrachospermum*					
Klebsormidium						*Audouinella*					
Spirogyra		-		P		*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) - Unidentified						*Phacus*					
Cladophora		-		P		**CRYPTOPHYTES** - *Cryptomonas*					
Chaetophora											
Stigeoclonium		P		-		**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*		P		P	
Parellela						*Fungi*		-		P	
Charophytes						*Protozoa*		P		P	
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA		10		18	

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Mangaoraka Stream collected in akick net on the 07 March (*) and 27 March (^) 1998 in 3 Ring Plain stream sites.

SITE	*		^		^
Site Code MRK000	110		380		480
GREEN ALGAE (Unicellular)					
Unidentified (nannoplankton)					
Ankistrodesmus	-		P		-
Closterium					
Chlorella					
Oocystis					
Staurastrum					
Tetraedron					
Chlamydomonas					
Selenastrum					
Polyedriopsis					
Chodatella					
Euastrum					
Cosmarium					
Micrasterias					
Diacanthos					
Characium					
Netrium					
Carteria					
Haematococcus					
Arthrodesmus					
(Colonial) – Unidentified					
Coelastrum					
Botryococcus					
Planktosphaeria					
Dictyosphaerium					
Kirchneriella					
Sphaerocystis					
Gloeocystis					
Golenkinia					
Micractinium					
Scenedesmus	-		P		-
Pediastrum					
Actinastrum					
Volvox					
Pandorina					
Eudorina					
Tetraspora					
Enteromorpha					
Ulva					
(Unbranched filaments) - Unidentified					
Oedogonium	P		P		A
Ulothrix					
Klebsormidium					
Spirogyra					
Spondylosium					
Hyalotheca					
Desmidium					
Microspora					
Mougeotia					
Zygnema					
(Branched filaments) - Unidentified					
Cladophora	P		P		A
Chaetophora					
Stigeoclonium					
Draparnaldia					
Parellela					
Charophytes					
YELLOW GREEN ALGAE					
Tribonema					
Vaucheria					

SITE					
CYANOBACTERIA - Unidentified					
Anabaena					
Oscillatoria	P		P		P
Microcystis					
Nostoc					
Tolypothrix					
Spirulina					
Stigonema					
Lyngbya	P		P		P
Microcoleus	P		-		-
Scytonema					
Phormidium	-		P		-
Chamaesiphon	-		-		P
DIATOMS (Unicellular) - Unknown					
Synedra	-		A		P
Nitzschia	-		A		P
Navicula	P		A		P
Hanzschia					
Stauroneis					
Gyrosigma					
Cymbella	-		P		P
Rhopalodia					
Gomphonema/Gomphenemis	P		P		A
Rhoicosphenia	-		P		P
Pinnularia					
Cocconeis	P		P		P
Diploneis					
Cyclotella					
Epithemia					
Eunotia					
Eunotia serpentina					
Surirella	-		P		-
Achnanthes	P		P		P
Fragilaria					
Asterionella					
Tabellaria					
Diatoma					
Melosira	-		P		P
GOLDEN BROWN ALGAE					
Dinobryon					
Mallomonas					
Synura					
RHODOPHYTES					
Bostrychia					
Batrachospermum					
Audouinella					
Chroodactylon					
Compsopogon					
Boldia					
DINOFLAGELLATES - *Peridinium* group					
EUGLENOIDS					
Trachelomonas					
Euglena					
Phacus					
CRYPTOPHYTES - *Cryptomonas*					
NON-ALGAL GROUPS:					
Non-pigmented filamentous bacteria	P		P		P
Fungi	P		P		-
Protozoa	P		P		P
NUMBER OF TAXA	12		20		16

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Timaru Stream collected in a kick net on the 23 March 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code TMR000		150		375		**CYANOBACTERIA** - Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*					
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus						*Nostoc*					
Closterium						*Tolypothrix*					
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*		P		P	
Tetraedron						*Microcoleus*					
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*					
Polyedriopsis						*Chamaesiphon*					
Chodatella						**DIATOMS (Unicellular)** - Unknown					
Euastrum						*Synedra*		-		P	
Cosmarium						*Nitzschia*					
Micrasterias						*Navicula*		P		P	
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*					
Carteria						*Cymbella*					
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*		P		P	
(Colonial) - Unidentified						*Rhoicosphenia*					
Coelastrum						*Pinnularia*					
Botryococcus						*Cocconeis*					
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*					
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*					
Micractinium						*Achnanthes*					
Scenedesmus						*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*					
Volvox						*Diatoma*					
Pandorina						*Melosira*		-		P	
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha						*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) - Unidentified						**RHODOPHYTES**					
Oedogonium		-		P		*Bostrychia*					
Ulothrix						*Batrachospermum*					
Klebsormidium						*Audouinella*					
Spirogyra		P		P		*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) - Unidentified						*Phacus*					
Cladophora		-		P		**CRYPTOPHYTES** - *Cryptomonas*					
Chaetophora											
Stigeoclonium						**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*					
Parellela						*Fungi*					
Charophytes						*Protozoa*					
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA		4		8	

P = Present A = Abundant VA = Very abundant ? = Uncertain

Benthic microflora of the Patea River collected in a kick nett on the 12 (*), 13(^) and 16 (#) February 1998 in 5 Ring Plain stream sites.

SITE	*	^	^	#	*
Site Code PAT000	200	225	287	358	360
GREEN ALGAE (Unicellular)					
Unidentified (nannoplankton)					
Ankistrodesmus	-	-	P	-	P
Closterium					
Chlorella					
Oocystis					
Staurastrum					
Tetraedron					
Chlamydomonas					
Selenastrum					
Polyedriopsis					
Chodatella					
Euastrum					
Cosmarium					
Micrasterias					
Diacanthos					
Characium					
Netrium					
Carteria					
Haematococcus					
Arthrodesmus					
(Colonial) - Unidentified					
Coelastrum					
Botryococcus					
Planktosphaeria					
Dictyosphaerium					
Kirchneriella					
Sphaerocystis					
Gloeocystis					
Golenkinia					
Micractinium					
Scenedesmus	-	-	P	P	-
Pediastrum					
Actinastrum					
Volvox					
Pandorina					
Eudorina					
Tetraspora					
Enteromorpha					
Ulva					
(Unbranched filaments) - Unidentified					
Oedogonium	-	-	A	P	P
Ulothrix					
Klebsormidium					
Spirogyra	P	-	P	-	P
Spondylosium					
Hyalotheca					
Desmidium					
Microspora					
Mougeotia					
Zygnema					
(Branched filaments) - Unidentified					
Cladophora	-	-	P	P	P
Chaetophora					
Stigeoclonium					
Draparnaldia					
Parellela					
Charophytes					
YELLOW GREEN ALGAE					
Tribonema					
Vaucheria					

SITE					
BLUE GREEN ALGAE - Unidentified					
Anabaena					
Oscillatoria	P	P	A	P	P
Microcystis					
Nostoc					
Tolypothrix	-	P	-	-	-
Spirulina					
Stigonema					
Lyngbya	-	-	P	P	P
Microcoleus	-	-	-	P	-
Scytonema					
Phormidium	P	-	-	-	P
Chamaesiphon	-	-	P	P	-
DIATOMS (Unicellular) - Unknown	-	P	-	-	-
Synedra	-	-	P	P	P
Nitzschia	-	P	P	P	-
Navicula	P	P	P	P	P
Hanzschia	-	-	-	-	P
Stauroneis					
Gyrosigma					
Cymbella	-	P	P	P	P
Rhopalodia					
Gomphonema/Gomphenemis	-	P	P	-	P
Rhoicosphenia	-	P	P	P	P
Pinnularia	-	-	-	-	P
Cocconeis	-	-	P	-	P
Diploneis					
Cyclotella	-	-	-	P	-
Epithemia					
Eunotia					
Eunotia serpentina					
Surirella	-	-	P	-	-
Achnanthes	-	P	P	P	A
Fragilaria					
Asterionella					
Tabellaria					
Diatoma					
Melosira	-	-	A	P	A
GOLDEN BROWN ALGAE					
Dinobryon					
Mallomonas					
Synura					
RHODOPHYTES					
Bostrychia					
Batrachospermum					
Audouinella					
Chroodactylon					
Compsopogon					
Boldia					
DINOFLAGELLATES - *Peridinium* group					
EUGLENOIDS					
Trachelomonas					
Euglena					
Phacus					
CRYPTOPHYTES - *Cryptomonas*					
NON-ALGAL GROUPS:					
Non-pigmented filamentous bacteria	P	P	P	P	P
Fungi	P	P	-	-	-
Protozoa	P	-	P	P	P
NUMBER OF TAXA	7	11	20	17	19

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Punehu Stream collected in a kick net on the 23 March 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code	PNH000		210		800	**BLUE GREEN ALGAE** – Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*		P		P	
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus		P		A		*Nostoc*					
Closterium						*Tolypothrix*					
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*		P		P	
Tetraedron						*Microcoleus*					
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*		P		-	
Polyedriopsis						*Chamaesiphon*		P		-	
Chodatella						**DIATOMS (Unicellular)** - Unknown					
Euastrum						*Synedra*		P		VA	
Cosmarium						*Nitzschia*		P		A	
Micrasterias						*Navicula*		P		P	
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*					
Carteria						*Cymbella*		P		P	
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*		P		A	
(Colonial) – Unidentified						*Rhoicosphenia*		P		P	
Coelastrum						*Pinnularia*		-		P	
Botryococcus						*Cocconeis*					
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*					
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*		P		-	
Micractinium						*Achnanthes*		P		P	
Scenedesmus						*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*					
Volvox						*Diatoma*					
Pandorina						*Melosira*		P		A	
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha						*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) – Unidentified						**RHODOPHYTES**					
Oedogonium		P		A		*Bostrychia*					
Ulothrix						*Batrachospermum*					
Klebsormidium						*Audouinella*					
Spirogyra		P		P		*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) – Unidentified						*Phacus*					
Cladophora		P		P		**CRYPTOPHYTES** - *Cryptomonas*					
Chaetophora											
Stigeoclonium		-		P		**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*		P		P	
Parellela						*Fungi*		P		-	
Charophytes						*Protozoa*		P		P	
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA		20		18	

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Stony River collected in a kick net on the 04 (*) and the 10 March (^) 1998 in 3 Ring Plain stream sites.

SITE	*		^			SITE					
Site Code STY000	260		280		400	**CYANOBACTERIA** - Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*					
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus						*Nostoc*	P		-		-
Closterium						*Tolypothrix*					
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*	P		-		-
Tetraedron						*Microcoleus*					
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*					
Polyedriopsis						*Chamaesiphon*					
Chodatella						**DIATOMS (Unicellular)** - Unknown					
Euastrum						*Synedra*	P		-		-
Cosmarium						*Nitzschia*	P		P		-
Micrasterias						*Navicula*	P		P		-
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*					
Carteria						*Cymbella*					
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*	P		P		-
(Colonial) - Unidentified						*Rhoicosphenia*	-		P		-
Coelastrum						*Pinnularia*					
Botryococcus						*Cocconeis*					
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*					
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*					
Micractinium						*Achnanthes*	P		-		-
Scenedesmus						*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*					
Volvox						*Diatoma*					
Pandorina						*Melosira*					
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha	P		P		-	*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) - Unidentified						**RHODOPHYTES**					
Oedogonium	-		P		-	*Bostrychia*					
Ulothrix						*Batrachospermum*					
Klebsormidium						*Audouinella*					
Spirogyra	P		P		-	*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) - Unidentified						*Phacus*					
Cladophora	-		P		-	**CRYPTOPHYTES** - *Cryptomonas*					
Chaetophora											
Stigeoclonium	P		P		-	**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*	P		-		-
Parellela						*Fungi*					
Charophytes						*Protozoa*	P		-		-
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA	12		9		0

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Waiongana Stream collected with a kick net on the 25 March 1998 in 4 Ring Plain stream sites.

SITE						SITE					
Site Code WGA	120	170	260	360		BLUE GREEN ALGAE - Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*	P	A	A	P	
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus						*Nostoc*					
Closterium						*Tolypothrix*	P	-	-	-	
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*	P	P	A	P	
Tetraedron						*Microcoleus*	-	P	-	-	
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*	P	-	-	-	
Polyedriopsis						*Chamaesiphon*		P			
Chodatella						**DIATOMS (Unicellular)** - Unknown	-	P	-	-	
Euastrum						*Synedra*	P	P	A	P	
Cosmarium						*Nitzschia*	P	P	A	A	
Micrasterias						*Navicula*	P	A	A	P	
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*					
Carteria						*Cymbella*	P	P	P	P	
Haematococcus						*Rhopalodia*					
Arthrodesmus	-	-	P	-		*Gomphonema/Gomphenemis*	P	A	VA	VA	
(Colonial) - Unidentified						*Rhoicosphenia*	P	P	P	P	
Coelastrum						*Pinnularia*					
Botryococcus						*Cocconeis*	-	-	P	P	
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*					
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*					
Micractinium						*Achnanthes*	P	P	P	P	
Scenedesmus	P	-	P	P		*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*					
Volvox						*Diatoma*					
Pandorina						*Melosira*	P	P	A	P	
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha						*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) - Unidentified						**RHODOPHYTES**					
Oedogonium	P	P	A	P		*Bostrychia*					
Ulothrix	-	-	P	-		*Batrachospermum*					
Klebsormidium						*Audouinella*					
Spirogyra	P	P	P	P		*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) - Unidentified						*Phacus*					
Cladophora	-	P	A	P		**CRYPTOPHYTES** - *Cryptomonas*					
Chaetophora											
Stigeoclonium	-	-	P	P		**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*	P	P	P	P	
Parellela						*Fungi*	P	-	-	-	
Charophytes						*Protozoa*	P	-	P	P	
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA	18	17	20	18	

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Waingongoro River collected in a kick net on the 19 March 1998 in 6 Ring Plain stream sites.

SITE						SITE					
Site Code WGG000	150		490		550	**CYANOBACTERIA** – Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*	-		P		P
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus	-		A		VA	*Nostoc*	P		-		-
Closterium						*Tolypothrix*					
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*	-		P		P
Tetraedron						*Microcoleus*	-		P		-
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*	-		P		-
Polyedriopsis						*Chamaesiphon*	P		P		-
Chodatella						**DIATOMS (Unicellular)** - Unknown	-		-		P
Euastrum						*Synedra*	-		P		P
Cosmarium						*Nitzschia*	-		P		A
Micrasterias						*Navicula*	P		P		A
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*					
Carteria						*Cymbella*	-		P		P
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*	-		A		P
(Colonial) – Unidentified						*Rhoicosphenia*	-		-		P
Coelastrum						*Pinnularia*					
Botryococcus						*Cocconeis*					
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*					
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*	P		-		-
Micractinium						*Achnanthes*	-		P		P
Scenedesmus	-		P		P	*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*	-		-		P
Volvox						*Diatoma*					
Pandorina						*Melosira*	-		P		P
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha						*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) - Unidentified						**RHODOPHYTES**					
Oedogonium	-		P		-	*Bostrychia*	P		-		-
Ulothrix						*Batrachospermum*					
Klebsormidium						*Audouinella*					
Spirogyra						*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) - Unidentified						*Phacus*					
Cladophora	-		P		-	**CRYPTOPHYTES** – *Cryptomonas*					
Chaetophora											
Stigeoclonium						**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*	P		-		-
Parellela						*Fungi*	P		P		P
Charophytes						*Protozoa*	-		-		P
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA	7		17		16

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Waingongoro River collected in a kick net on the 20 March 1998 in 6 Ring Plain stream sites.

SITE						SITE					
Site Code	WGG000	680		778		895	**CYANOBACTERIA** – Unidentified					
							Anabaena					
GREEN ALGAE (Unicellular)							*Oscillatoria*	P		P		P
Unidentified (nannoplankton)							*Microcystis*					
Ankistrodesmus		A		P		A	*Nostoc*					
Closterium							*Tolypothrix*					
Chlorella							*Spirulina*					
Oocystis							*Stigonema*					
Staurastrum							*Lyngbya*	P		P		-
Tetraedron							*Microcoleus*	P		-		P
Chlamydomonas							*Scytonema*					
Selenastrum							*Phormidium*	P		-		-
Polyedriopsis							*Chamaesiphon*					
Chodatella							**DIATOMS (Unicellular)** - Unknown	-		P		-
Euastrum							*Synedra*	P		P		P
Cosmarium							*Nitzschia*	P		P		P
Micrasterias							*Navicula*	P		A		P
Diacanthos							*Hanzschia*					
Characium							*Stauroneis*					
Netrium							*Gyrosigma*	-		P		-
Carteria							*Cymbella*	P		P		P
Haematococcus							*Rhopalodia*					
Arthrodesmus							*Gomphonema/Gomphenemis*	P		P		P
(Colonial) – Unidentified							*Rhoicosphenia*	P		P		P
Coelastrum							*Pinnularia*	-		-		P
Botryococcus							*Cocconeis*	P		P		P
Planktosphaeria							*Diploneis*					
Dictyosphaerium							*Cyclotella*					
Kirchneriella							*Epithemia*					
Sphaerocystis							*Eunotia*					
Gloeocystis							*Eunotia serpentina*					
Golenkinia							*Surirella*					
Micractinium							*Achnanthes*	P		P		P
Scenedesmus		P		-		P	*Fragilaria*					
Pediastrum							*Asterionella*					
Actinastrum							*Tabellaria*					
Volvox							*Diatoma*					
Pandorina							*Melosira*	P		A		P
Eudorina							**GOLDEN BROWN ALGAE**					
Tetraspora							*Dinobryon*					
Enteromorpha							*Mallomonas*					
Ulva							*Synura*					
(Unbranched filaments) - Unidentified							**RHODOPHYTES**					
Oedogonium		P		P		P	*Bostrychia*					
Ulothrix							*Batrachospermum*					
Klebsormidium							*Audouinella*					
Spirogyra							*Chroodactylon*					
Spondylosium							*Compsopogon*					
Hyalotheca							*Boldia*					
Desmidium							**DINOFLAGELLATES** - *Peridinium* group					
Microspora							**EUGLENOIDS**					
Mougeotia							*Trachelomonas*					
Zygnema							*Euglena*					
(Branched filaments) - Unidentified							*Phacus*					
Cladophora		P		-		P	**CRYPTOPHYTES** – *Cryptomonas*					
Chaetophora												
Stigeoclonium		-		P		P	**NON-ALGAL GROUPS:**					
Draparnaldia							*Non-pigmented filamentous bacteria*	-		-		P
Parellela							*Fungi*	-		-		P
Charophytes							*Protozoa*	P		P		P
YELLOW GREEN ALGAE												
Tribonema												
Vaucheria							NUMBER OF TAXA	18		17		20

P = Present A = Abundant (≥50% of slide), VA = Very abundant (75% of slide).

Benthic microflora of the Waiwakaiho River collected in a kick net on the 08 (*), 17 (^) and the 19 (#) April 1998 in 4 Ring Plain stream sites.

SITE	^	*	#	#
Site Code WKH000	185	475	687	860
GREEN ALGAE (Unicellular)				
Unidentified (nannoplankton)				
Ankistrodesmus	-	-	P	P
Closterium				
Chlorella				
Oocystis				
Staurastrum				
Tetraedron				
Chlamydomonas				
Selenastrum				
Polyedriopsis				
Chodatella				
Euastrum				
Cosmarium				
Micrasterias				
Diacanthos				
Characium				
Netrium				
Carteria				
Haematococcus				
Arthrodesmus				
(Colonial) - Unidentified				
Coelastrum				
Botryococcus				
Planktosphaeria				
Dictyosphaerium				
Kirchneriella				
Sphaerocystis				
Gloeocystis				
Golenkinia				
Micractinium				
Scenedesmus	P	-	P	-
Pediastrum	-	-	-	P
Actinastrum				
Volvox				
Pandorina				
Eudorina				
Tetraspora				
Enteromorpha				
Ulva				
(Unbranched filaments) - Unidentified				
Oedogonium	P	P	A	A
Ulothrix				
Klebsormidium				
Spirogyra	P	A	-	P
Spondylosium				
Hyalotheca				
Desmidium				
Microspora				
Mougeotia				
Zygnema				
(Branched filaments) - Unidentified				
Cladophora	-	-	A	A
Chaetophora				
Stigeoclonium	-	-	-	P
Draparnaldia				
Parellela				
Charophytes				
YELLOW GREEN ALGAE				
Tribonema				
Vaucheria				

SITE				
BLUE GREEN ALGAE - Unidentified				
Anabaena				
Oscillatoria	-	P	P	P
Microcystis	P	-	-	-
Nostoc	-	P	-	-
Tolypothrix				
Spirulina				
Stigonema				
Lyngbya	-	P	P	P
Microcoleus	-	-	P	-
Coleodesmium	-	-	P	-
Phormidium	-	P	-	P
Chamaesiphon	-	P	P	P
DIATOMS (Unicellular) - Unknown	-	P	-	-
Synedra	P	A	P	A
Nitzschia	P	P	P	P
Navicula	P	P	P	P
Hanzschia				
Stauroneis				
Gyrosigma				
Cymbella	P	P	P	A
Rhopalodia				
Gomphonema/Gomphenemis	P	A	P	A
Rhoicosphenia	P	P	P	P
Pinnularia				
Cocconeis	-	-	P	P
Diploneis				
Cyclotella				
Epithemia	P	-	-	-
Eunotia				
Eunotia serpentina				
Surirella				
Achnanthes	P	P	P	A
Fragilaria				
Asterionella				
Tabellaria				
Diatoma				
Melosira	-	-	P	P
GOLDEN BROWN ALGAE				
Dinobryon				
Mallomonas				
Synura				
RHODOPHYTES				
Bostrychia				
Batrachospermum				
Audouinella	-	-	P	-
Chroodactylon				
Compsopogon				
Boldia				
DINOFLAGELLATES - *Peridinium* group				
EUGLENOIDS				
Trachelomonas				
Euglena				
Phacus				
CRYPTOPHYTES - *Cryptomonas*				
NON-ALGAL GROUPS:				
Non-pigmented filamentous bacteria	P	P	-	P
Fungi	P	-	-	P
Protozoa	P	-	-	P
NUMBER OF TAXA	15	16	19	22

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

Benthic microflora of the Waitara River collected in a kick net on the 09 March 1998 in 2 Ring Plain stream sites.

SITE						SITE					
Site Code WTR000		800		890		**CYANOBACTERIA** - Unidentified					
						Anabaena					
GREEN ALGAE (Unicellular)						*Oscillatoria*		-		P	
Unidentified (nannoplankton)						*Microcystis*					
Ankistrodesmus		P		-		*Nostoc*					
Closterium						*Tolypothrix*		P		-	
Chlorella						*Spirulina*					
Oocystis						*Stigonema*					
Staurastrum						*Lyngbya*		P		P	
Tetraedron						*Microcoleus*		P		-	
Chlamydomonas						*Scytonema*					
Selenastrum						*Phormidium*					
Polyedriopsis						*Chamaesiphon*		P		-	
Chodatella						**DIATOMS (Unicellular)** - Unknown					
Euastrum						*Synedra*		P		P	
Cosmarium		P		-		*Nitzschia*		P		A	
Micrasterias						*Navicula*		P		A	
Diacanthos						*Hanzschia*					
Characium						*Stauroneis*					
Netrium						*Gyrosigma*		P		P	
Carteria	-					*Cymbella*		P		P	
Haematococcus						*Rhopalodia*					
Arthrodesmus						*Gomphonema/Gomphenemis*		P		P	
(Colonial) - Unidentified						*Rhoicosphenia*		P		P	
Coelastrum						*Pinnularia*		-		P	
Botryococcus						*Cocconeis*		P		P	
Planktosphaeria						*Diploneis*					
Dictyosphaerium						*Cyclotella*					
Kirchneriella						*Epithemia*					
Sphaerocystis						*Eunotia*					
Gloeocystis						*Eunotia serpentina*					
Golenkinia						*Surirella*					
Micractinium						*Achnanthes*		P		P	
Scenedesmus		-		P		*Fragilaria*					
Pediastrum						*Asterionella*					
Actinastrum						*Tabellaria*					
Volvox						*Diatoma*					
Pandorina						*Melosira*		P		P	
Eudorina						**GOLDEN BROWN ALGAE**					
Tetraspora						*Dinobryon*					
Enteromorpha		-		P		*Mallomonas*					
Ulva						*Synura*					
(Unbranched filaments) - Unidentified						**RHODOPHYTES**					
Oedogonium		A		P		*Bostrychia*					
Ulothrix						*Batrachospermum*					
Klebsormidium						*Audouinella*					
Spirogyra						*Chroodactylon*					
Spondylosium						*Compsopogon*					
Hyalotheca						*Boldia*					
Desmidium						**DINOFLAGELLATES** - *Peridinium* group					
Microspora						**EUGLENOIDS**					
Mougeotia						*Trachelomonas*					
Zygnema						*Euglena*					
(Branched filaments) - Unidentified						*Phacus*					
Cladophora		P		P		**CRYPTOPHYTES** - *Cryptomonas*					
Chaetophora											
Stigeoclonium		-		P		**NON-ALGAL GROUPS:**					
Draparnaldia						*Non-pigmented filamentous bacteria*		-		P	
Parellela						*Fungi*		P			
Charophytes						*Protozoa*		P		P	
YELLOW GREEN ALGAE											
Tribonema											
Vaucheria						NUMBER OF TAXA		20		20	

P = Present A = Abundant (≥50% of slide), VA = Very abundant (≥75% of slide).

APPENDIX 5

Chemical data from 83 stream sites in the Taranaki Ring Plain sampled between February and May 1998.

Site No.	Temperature (°C)	Conductivity (mSm^{-1})	BOD (Kg/day)	Suspended Solids (M^3/day)	Turbidity (NTU)	pH
A1	8.80	11.10	0.00	0.00	1.20	7.40
A2	13.20	12.30	0.00	0.00	2.20	7.30
A3	14.60	18.20	23.00	4365.90	4.50	7.50
A4	17.90	22.90	40.80	13041.40	1.70	7.30
A5	16.80	26.70	46.80	13053.50	1.70	7.70
B1	13.80	10.00	13.85	27.70	0.55	7.70
C1	16.20	9.00	2.04	4.10	1.20	7.60
C2	12.70	9.40	2.04	4.10	1.80	7.60
C3	19.50	10.50	3.30	6.50	1.60	7.90
C4	20.50	10.60	5.60	10.70	1.80	8.80
D1	13.60	10.90	0.00	0.00	0.70	8.00
D2	16.10	12.20	2.84	5.68	0.55	8.30
D4	14.50	9.80	9.50	4926.60	0.70	8.30
E1	10.60	8.10	12.30	24.60	0.45	8.00
E4	13.50	8.30	62.50	166.80	0.55	8.50
E5	15.50	9.90	190.30	542.41	0.75	8.70
E6	19.80	12.00	215.00	591.60	0.75	9.40
F1	8.90	6.80	2.60	45.20	0.45	7.80
F2	9.20	8.60	17.60	75.10	0.65	7.70
F3	13.50	10.50	43.49	9726.98	0.75	8.20
F4	15.20	10.90	59.99	23919.88	0.60	9.40
G1	14.50	6.70	2.80	5.60	0.50	7.4
G2	16.90	8.40	5.00	10.00	1.40	8.20
G3	18.00	9.50	11.90	23.70	0.95	9.50
H1	14.30	11.60	1.70	3.40	2.50	7.80
H2	15.60	14.60	10.90	21.90	5.40	7.90
H3	16.10	17.10	37.60	75.10	2.00	8.00
I1	15.60	7.80	0.00	0.00	0.35	7.20
I2	13.70	5.40	0.00	0.00	0.35	7.50
J1	13.50	12.10	1.50	3.00	1.80	7.70
J2	16.70	23.90	7.50	43.00	0.70	8.50
J3	15.90	18.40	7.50	734.20	3.00	8.00
K1	11.90	10.00	35.20	8.70	0.50	7.60
L1	14.70	21.10	9.40	18.80	0.80	8.00
L2	17.10	25.60	17.45	56.60	1.30	8.10

Site No.	Temperature (°C)	Conductivity (mSm^{-1})	BOD (Kg/day)	Suspended Solids (Kg/day)	Turbidity (NTU)	pH
M1	9.30	6.00	0.00	0	.30	7.50
M2	13.20	8.10	9.40	18.80	.30	8.00
N1	13.00	4.40	2.20	4.40	.10	6.90
N2	14.10	8.10	6.80	13.60	.20	6.90
01	11.70	17.80	1.60	175.90	1.70	7.80
02	13.60	26.00	9.40	198.80	2.10	8.00
P1	9.90	8.20	0.00	0	0.30	7.80
P2	11.80	11.40	17.40	74.70	1.00	8.20
P3	13.00	12.60	17.40	74.70	1.20	8.00
P4	13.00	12.60	17.40	74.70	1.20	8.00
Q1	14.70	7.00	0.81	1.60	0.50	7.20
Q2	17.20	7.40	13.40	26.80	0.60	7.70
Q3	18.10	8.50	35.50	4689.25	0.60	7.70
Q4	20.50	10.30	204.90	82610.90	1.80	8.50
Q5	21.50	10.40	211.40	82610.90	1.50	8.70
R1	18.90	9.40	3.00	6.00	1.10	8.00
R2	17.50	11.90	22.20	44.30	1.20	9.10
S1	15.60	11.20	0.00	0	0.30	7.90
S2	16.20	11.50	0.00	0	0.25	8.00
S3	16.50	11.20	2.24	4.48	0.20	7.80
T1	11.30	7.10	0.00	0.00	0.45	7.60
U1	16.60	13.10	3.06	6.12	0.60	8.00
U2	19.90	14.30	18.60	37.3	0.75	7.90
V1	12.20	7.40	15.80	5221.65	0.40	7.80
V2	14.30	10.20	15.80	5722.65	0.80	8.10
V3	16.10	16.20	66.70	25789.76	1.20	8.90
V4	16.10	15.60	97.62	25853.53	1.10	9.20
W1	13.50	7.40	14.00	28.00	0.40	7.60
W2	15.70	10.40	79.12	2108542.20	0.90	8.00
W3	14.60	11.60	108.12	11871800.00	1.10	7.70
W4	16.50	14.10	137.32	11872100.00	1.80	8.40
W5	16.10	13.60	151.22	11872100.00	2.50	8.20
W6	16.70	14.40	186.12	11872200.00	2.00	8.00
X1	9.90	9.60	0.00	2246.00	0.45	7.80
X2	11.60	9.90	29.32	2305.40	0.50	8.00
X3	12.10	10.30	48.40	11109.50	0.55	8.20
X4	13.30	11.30	57.40	24719.60	0.55	8.40
Y1	14.80	14.20	8.60	17.30	0.70	8.30
Y2	15.10	16.20	21.80	43.60	0.55	8.80
Z1	20.90	9.50	198.00	25813.28	1.20	8.20
Z2	23.00	30.80	209.60	27747.18	1.70	8.00
AA1	15.00	10.10	0.00	0.00	0.80	8.00
AA2	15.80	12.50	8.70	17.4	0.65	8.70