SEASONAL AND YEAR TO YEAR VARIATION IN THE MACROINVERTEBRATE COMMUNITIES OF NEW ZEALAND FOREST STREAMS

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One of the ultimate advantages of an education is simply coming to the end of it.
- B.F. Skinner

ABSTRACT

The bed movement of 42 streams in the Ruahine Forest Park, Urewera National Park, and Cass-Craigieburn region was predicted from each stream's channel and catchment characteristics. While a stepwise regression was relatively unsuccessful in predicting tracer particle movement, an artificial neural network analysis achieved strong correlations with measured tracer particle data.

Forty-three streams in the Ruahine and Tararua Forest Parks were sampled in the summers of 1996 and 2001, and the macroinvertebrate communities compared. Changes in community structure between the two surveys did not correlate with any measured environmental characteristics including stream bed movement and change in periphyton biomass. MCI scores changed by a mean of 12.8 points between the two surveys, and the number of sites attaining an MCI score indicative of a 'pristine' stream dropped from 40 to 29. This appears to be related to a change in stream temperature, with streams that were cooler in 2001 than in 1996 showing an increase in MCI, while those which were warmer showed a decrease. Changes such as these could have a marked effect on biomonitoring programmes that use reference sites similar to these streams. In both 1996 and 2001, a greater number of taxa were collected from sites with more periphyton - taxon richness appears to asymptote at chlorophyll *a* concentrations greater than 5 $\mu g/cm^2$.

Twelve streams within the Ruahine Forest Park were sampled every three months between June 2000 and May 2001. Both periphyton biomass and macroinvertebrate taxon richness tended to decrease with bed movement. While macroinvertebrate community structure showed marked changes over the study period, these changes were not linked to bed movement or variation in periphyton level. The seasonal changes observed in these streams are not significantly different to the changes seen between the summers of 1996 and 2001 - community structure was no more stable between two summers separated by five years than it was between the seasons of a single year.

Eight artificial channels were laid on the bed of the Turitea Stream. At the onset of the experiment, half of the channels contained neither invertebrates nor periphyton cover, while the other half had no invertebrates but an initial periphyton layer. Drift samples indicate that approximately one in four drifting invertebrates colonised the channels during the 14 day study period, with benthic taxon richness reaching a peak after only four days. Colonisation was not affected by periphyton biomass. Some of the less common taxa that were present in the water column did not colonise the channels within 14 days.

EXPLANATION OF THE TEXT

This thesis is a combination of four individual papers, which has resulted in some repetition in the introductions and methods of some chapters.

Appendix 6 contains a fifth paper, which was presented at the 2001 Societas Internationalis Limnologiae Congress, held at the Clayton Campus of Monash University, Melbourne, Australia. This paper is to appear in Volume 28 of the Proceedings of the International Association of Theoretical and Applied Limnology, and is referred to within this thesis as 'Minchin & Death in press'.

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I would like to dedicate this thesis to my grandparents. Only one of you lasted long enough to see this produced, so Grandma, I'm expecting you to read it four times to make up the difference. Thank you for all of your financial support - without your generosity, I don't think that I would have made it this far. As with my parents, I hope that having me finish this thesis will make it seem worthwhile.

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Chapter 1:

GENERAL INTRODUCTION

Stream bed movement is perhaps the most frequently cited cause of disturbance and structuring of macroinvertebrate communities (e.g., Robinson & Minshall 1986; Resh *et al.* 1988; Matthaei *et al.* 1996; Townsend *et al.* 1997; Bond & Downes 2000, McCabe & Gottelli 2000). Disturbances, here defined as 'any relatively discrete event in time that removes organisms and opens up space or other resources which can be utilized by individuals of the same or different species' (Pickett & White 1985), may be particularly important in New Zealand stream communities due to the unpredictable nature of this country's hydrological regime (Winterbourn *et al.* 1981; Death & Winterbourn 1995).

Macroinvertebrate community structure is also affected by anthopogenic changes such as pollution or the removal of riparian vegetation. The invertebrate community may therefore be used as an indicator of waterway degradation (e.g., Stark 1985), but it is not clear how much change occurs naturally within a year, from year to year, or as a result of disturbances (Townsend *et al.* 1987), and it may be difficult to distinguish between natural and anthropogenic fluctuations. Changes in the communities of pristine 'reference sites' may influence the accuracy of stream biomonitoring programmes (Scarsbrook 2002), as it is the degree of difference between test and reference sites which determines our ability to identify degradation.

Scarsbrook (2002) has concluded that New Zealand macroinvertebrate communities may 'fluctuate around a relatively stable state', with greater inter-annual fluctuation at sites with more variable flows. A number of studies have investigated macroinvertebrate community change between years (e.g., Scarsbrook 2002; Townsend *et al.* 1987) and others have looked at change within a single year (e.g., Death & Winterbourn 1994), but few have compared these two quite different time scales. The purpose of this study is to determine what it is that causes change in the communities of forest streams over two time scales (intra-annual and between two summers separated by five years), with particular focus on disturbances by bed movement as a factor driving community change. Robinson & Minshall (1986) suggest that the factors which structure a community will differ according to season, while it makes intuitive sense that the factors will be similar in the same season of different years.

This study examines the effects of bed movement and periphyton biomass on the macroinvertebrate communities in Ruahine and Tararua Forest Park streams. The questions which this thesis aimed to investigate were:

1) Is temporal variation of macroinvertebrate communities greater in streams which have greater bed movement?

2) Do macroinvertebrate communities vary more between years or between seasons within a single year, and is this related to stream bed movement?

3) Can the differences in spatial and temporal patterns between stream communities be explained by periphyton biomass?

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