Benthic communities of the Whanganui River catchment: the effects of land use and geology

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ABSTRACT

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The response of macroinvertebrate communities and freshwater mussels to variation associated with land use and geology was investigated in small headwaters of the Whanganui River catchment in the North Island of New Zealand. Conductivity and water clarity were higher in streams with soft tertiary/quaternary sedimentary geology, independent of land use. These soft geology catchments, when forested, had distinctive community structure often involving high relative abundances of Ephemeroptera. Pastoral agriculture resulted in a lower diversity and abundance of pollution sensitive taxa. Impacts of pastoral land use were accentuated by soft sedimentary geology culminating in low diversity and abundance in pasture streams with soft geology. Multivariate analysis showed that community structure varied significantly depending on the combination of land use and geology type present, with land use as the most significant factor. However, variations in geology may mask the effects of land use between catchments.

In the main Whanganui River, taxonomic diversity and numbers of pollution sensitive taxa decreased downstream. This was correlated with reduced periphyton biomass and increased suspensoids. Estimates of macroinvertebrate community structure differed between artificial substrate and kick samples collected from the same sites.

Shell morphology of the freshwater mussel *Hyridella menziesi* was not correlated with water chemistry. One site near the northern boundary of the Whanganui River catchment contained mussels with distinct shell morphology. A possible explanation involving stream capture by tectonic movements is considered. Shell erosion was correlated with channel width suggesting shell erosion is greater in larger waterways. Lack of demarcation in shell growth annuli meant accurate estimates of mussel age were not possible. Poor demarcation is likely to result from non seasonal patterns of environmental variation.

Chapter One

General introduction

INTRODUCTION

The character of streams and rivers reflects the integration of physical and biological processes occurring in the catchment (Johnson and Gage, 1997). Most of the Whanganui River catchment (Fig. 1.1) was once heavily forested but much of this land has been cleared for pastoral agriculture. Some of these areas have been retired allowing the native vegetation to re-grow. The land is young in geological terms consisting predominantly of Pliocene-Pleistocene marine sediments or volcanics which are younger than most of the North Island. Various unconsolidated rock types combined with low gradient provide suitable soft bottom habitats for the New Zealand freshwater mussel *Hyridella menziesi*. Many ecological features of this species are well documented in lakes but little is known of the populations present in the Whanganui River, or other lotic habitats.

The landscape influences it's water bodies through multiple pathways and mechanisms, operating at different spatial scales (Allan and Johnson, 1997). Large scale factors influencing stream ecosystem function such as geology and land use (Winterbourn, 1986) have an important influence on the physicochemical characteristics of streams (Richards *et al.*, 1997). Macroinvertebrate community structure is closely linked to these characteristics making them appropriate indicators for investigating environmental change (Stark, 1993). Changes in land use practices such as those related to agricultural development are predicted to alter habitat characteristics, invertebrate community composition and water quality (Lenat, 1984; Corkum, 1990; Quinn and Hickey, 1990b). Catchment geology also affects the structure of aquatic ecosystems over a range of spatial scales through its influence on water chemistry (Maasdam and Smith, 1994), catchment vegetation, flow variability and substrate characteristics (Cummins *et al.*, 1984; Richards *et al.*, 1997). Catchments with a combination of pastoral agriculture and soft sedimentary geology can have distinctive community structure such as low abundance and diversity (Quinn and Hickey, 1990a; Davies-Colley and Stroud, 1995). The substrate of many streams in the Whanganui River catchment are dominated by erodable Tertiary aged sedimentary rock. Little is known about the basic ecology of invertebrate communities in these mudstone streams, and the influence of land use upon them.

Hyridella menziesi is abundant throughout many lakes in both the North Island and South Island. However, little is known about this species in the Whanganui River catchment. Anecdotal evidence concerning the distribution and abundance of *Hyridella menziesi* in the Whanganui River catchment suggest that the species has declined since the turn of the century. Clearly, more information concerning their response to environmental variation will be beneficial to understanding reasons for their decline.

Increased knowledge of ecological conditions that occur in the main river and its tributaries will provide greater understanding of environmental and ecological characteristics of the Whanganui River. Chapter Two investigates the effects of pastoral land use and geology type on macroinvertebrate communities in headwater streams, in particular those from catchments with soft sedimentary geology. Longitudinal changes in macroinvertebrate communities along the main Whanganui River in response to tributary inputs are explored in Chapter Three. The use of both artificial substrate and kick sampling were used to assess these changes and their respective abilities to do so were compared. In Chapter Four, morphological and spatial characteristics of the New Zealand freshwater mussel *Hyridella menziesi* are investigated in relation to physicochemistry and habitat from six sites in the Whanganui river and its tributaries.

Figure 1.1. Map showing the position of the Whanganui River catchment in the North Island of New Zealand.

REFERENCES

Allan, D.J. and Johnson, L.B. 1997. Catchment style analysis of aquatic ecosystems. Freshwater Biology **37:** 107-111.

Corkum, L.D. 1990. Intrabiome distributional patterns of lotic macroinvertebrate assemblages. Canadian Journal of Fisheries and Aquatic Sciences **47:** 2147-2157.

Cummins, K.W., Minshall, G.W., Sedall, J. R., Cushing, C. E. and Petersen, R. C. 1984. Stream Ecosystem Theory. Verhandlungen der Internationalen Vereinigung für theoretisch und angewandte Limnologie **22:** 1818-1827.

Davies-Colley, R.J. and Stroud, M.J. 1995. Water quality degradation by pastoral agriculture in the Whanganui River catchment. Hamilton: National Institute of Water and Atmospheric Research. Consultancy Report DoC050/1.

Johnson, L.B. and Gage, S.H. 1997. Landscape approaches to the analysis of aquatic ecosystems. Freshwater Biology **37:** 113-132.

Lenat, D.R. 1984. Agriculture and stream water quality: a biological evaluation of erosion control practices. Environmental Management **8:** 333-344.

Maasdam, R. and Smith, D.G. 1994. New Zealand's National River Water Quality Network 2. Relationships between physico-chemical data and environmental factors. New Zealand Journal of Marine and Freshwater Research **28:** 37-54.

Quinn, J.M. and Hickey, C.W. 1990a. Characterisation and classification of benthic invertebrate communities in 88 New Zealand rivers in relation to environmental factors. New Zealand Journal of Marine and Freshwater Research **24:** 387-409.

Quinn, J.M. and Hickey, C.W. 1990b. Magnitude of effects of substrate particle size, recent flooding and catchment development on benthic invertebrates in 88 New Zealand rivers. New Zealand Journal of Marine and Freshwater Research **24:** 411-427.

Richards, C., Haro, R.J., Johnson, L.B. and Host, G.E. 1997. Catchment and reach-scale properties as indicators of macroinvertebrate species traits. Freshwater Biology **37:** 219-230.

Stark, J.D. 1993. Performance of the Macroinvertebrate Community Index: effects of sampling method, sample replication, water depth, current velocity, and substratum on index values. New Zealand Journal of Marine and Freshwater Research **21:** 463-478.

Winterbourn, M.J. 1986. Effects of land development on benthic stream communities. New Zealand Agricultural Science **20:** 115-118.