The influence of hydrology and landscape on stream invertebrate communities of the Whanganui Catchment, New Zealand

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Abstract

This study examines the effect of the hydrological regime and landscape characteristics on benthic stream macroinvertebrate communities in the Whanganui Catchment, New Zealand, using a variety of statistical techniques. A total of 36 hydrological variables were considered. Thirteen of these were calculated from long-term flow and rainfall records, and interpolated using geographic information systems (GIS) to cover the area of interest. Ten hydrological variables were derived from topographical maps though GIS, with a further 13 hydrological variables determined from rainfall information relating to the timing since the last event. Catchment and riparian landscape variables (land cover, geology and soil type) were derived from New Zealand's land classification database and land resource inventory using GIS. Community structure was measured using an ordination, species richness, total number of animals and the densities of 22 common taxa. Biological data was also quantified with a variety of diversity and water quality indices including Simpson's, Margalef's and Macroinvertebrate Community Index.

Individual links between biological and all environmental data were explored through Pearson's correlations. Multiple regression was used to examine the combination of the environmental variables that were best in determining individual characteristics of community structure. Canonical correlation was utilized to assess overall concurrent patterns between landscape and biotic data. Stepwise logistic regression and classification trees were used to explore occurrence of the 22 selected taxa in relation to environmental variables. Of the modelling techniques assessed for prediction of taxa occurrence classification trees gave as good or better predictions than the other models and tended to produce simpler models, suggesting that it is probably a better modelling technique for this data.

Of the environmental variables, FRE3 (number of flood events per year over 3 times the medium flow) was the best individual predictor of community structure, showing the greatest number of links and strongest relationships with the biotic variables. The other hydrological variables of river size and specific discharge also had numerous individual correlations, and as they are easier to calculate they may be more appropriate for use in ecological studies. Time since the last event was another important component in

determining invertebrate community structure. Hydrological characteristics dominated the explanatory variables in many of the models representing water quality and diversity indices, suggesting that indices that measure water quality and diversity may only be comparable over areas with similar hydrological regimes.

Landscape variables, as measured by this study, were also shown to influence invertebrate community structure but to a lesser extent than hydrology. All indices and ordinations show significant multiple regressions with landscape variables with 12 out of the 22 taxa models being highly significant. Canonical correlations of landscape variables showed catchment scale variables to be more predictive of community structure than riparian scale variables. When separating landscape variables into land cover and geology no clear pattern of dominance was shown.

Explanation of text

This thesis is a combination of 4 papers. This has resulted in some repetition in introductions, site description and methods between chapters. Chapter 2 is in the process of being submitted to Journal of the North American Benthological Society and Chapters 3, 4 and 5 to New Zealand Journal of Marine and Freshwater. Formatting of text follows the guidelines set out by the Journal of the North American Benthological Society.

Numbering of figures and tables is restarted for each chapter.

Raw data

Data for this study has been sourced from numerous individuals and organisations and as such raw data is not supplied in the Appendices. If you with to obtain original data please contact Dawn Lemke [redacted] or Russell Death (Ecology Department, Massey University, R.G.Death@massey.ac.nz).

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