ISSN 0117-2001

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 39

SUITABILITY OF USE CURVES FOR BENTHIC INVERTEBRATES

by

J. Richardson

Report to: Department of Conservation

Final report: Investigation No. S5065/334

Freshwater Fisheries Centre

MAF Fisheries

PO Box 6016

ROTORUA

Servicing freshwater fisheries and aquaculture

JUNE
1990

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORTS

This report is one of a series initiated in January 1989, and issued by the Freshwater Fisheries Centre, MAF Fisheries. The series was established to ensure that reports prepared for clients, tribunal hearings, internal use, etc., are collected together and available to future users. They are for limited circulation, and some may be confidential.

ISBN 0-477-08187-8

MAF

MAF Fisheries is the fisheries business group of the New Zealand Ministry of Agriculture and Fisheries. The name MAF Fisheries was formalised on 1 November 1989 and replaces MAFFish, which was established on 1 April 1987. It combines the functions of the former Fisheries Research and Fisheries Management Divisions, and the fisheries functions of the former Economics Division of MAF.

Enquiries to: The Librarian
Freshwater Fisheries Centre
PO Box 8324
Riccarton, Christchurch

INTRODUCTION

Benthic invertebrates are the major food source of most native and introduced fish in New Zealand (eg., Burnet 1969, Sagar and Eldon 1983). Past research on the invertebrate fauna of rivers and streams has given us valuable knowledge of the species present, their geographical range, life history patterns, what is a "typical" community assemblage, and how floods, nutrient enrichment, pollution, or water chemistry might affect these (eg., Towns 1979, Collier and Winterbourn 1987). However, little quantitative research has been carried out on the microhabitat of New Zealand species - the specific ranges of depth, water velocity, substrate, and other factors which these animals prefer.

Information about invertebrate microhabitat has practical application. Perhaps of primary interest to fishery and water managers is that the data can be used to develop habitat suitability curves for use with the instream flow incremental methodology (IFIM). The IFIM is a computer modelling technique which integrates simulated hydraulic conditions in waterways with physical information on the fish or invertebrate habitat suitability (Bovee 1982). The purpose is to predict potential suitable physical habitat for particular species or life stages at specified discharges.

Incorporating aspects such as food production into the IFIM model is important, because invertebrates often require different habitats to fish. However, it is important that the habitat suitability curves used are valid for the country, the species, and, ideally, the river where the method is being applied. At present, IFIM models used in New Zealand rely on curves developed overseas, which may be invalid here (Jowett 1982, Mosley and Jowett 1985).

The obvious need for quantitative data on invertebrate microhabitats prompted MAF Fisheries to begin this study in late 1985. The study had four objectives:

1. to investigate the influence of depth, velocity, and substrate on benthic invertebrate distribution and density;

2. to compare methods of developing habitat suitability functions for the predominate species (*Deleatidium* spp.);

3. to combine these functions into joint suitability models and compare their ability to predict *Deleatidium* spp. abundance;

4. to examine the model residuals for other factors which might influence invertebrate abundance.

METHODS

1986/87

1. Invertebrate samplers which could be used in various habitat conditions were developed and tested.

2. Hydraulic information (depth, water velocity, and substrate composition) and benthic invertebrate samples were collected from 87 points on the Waingawa River in November.

1987/88

1. Each invertebrate sample was sorted into nine groups and the number of individuals counted and weighed. Seven groups (*Deleatidium* spp., other mayflies, uncased caddisflies, cased caddisflies, beetles, Diptera, and stoneflies) were used in the analysis.

2. Habitat preferences were determined by comparing the means and variance of the habitat, weighted by the number of invertebrates, against the mean and variance of the sampling sites.

3. Weighted linear regression was used to explore size-related habitat preferences.

1988/89

1. Univariate suitability curves were derived for *Deleatidium* spp. by fitting smooth curves by eye and by fitting curves using mathematical functions. Multivariate models were developed by combining the univariate curves in various ways. Correlation coefficients were used as a measure of the ability of the curve or model to predict *Deleatidium* spp. abundance.

2. Model residuals were compared with an antecedent habitat index, transect hydraulic friction, calculated bottom velocity, substrate embeddedness, and periphyton abundance to determine whether any of these factors were related to invertebrate abundance.

1989/90

1. Data from the Clutha River were obtained from DSIR and compared with the Waingawa data using the methods described previously.

OUTPUTS AND RESULTS

1986/87

1. An article was published in *Freshwater Catch* (No. 36: 6-7) describing the project and presenting some preliminary results.

1987/88

1. *Deleatidium* spp. were the dominant invertebrate in terms of both numbers and biomass. Beetles were the second most numerous group, and other mayflies contributed about 17% of the biomass, owing to their relatively large size.

2. All seven groups, except uncased caddisflies and *Deleatidium* spp., exhibited significant preferences for either substrate, water velocity, or depth when each habitat variable was considered separately.

3. Six of the seven groups exhibited significant size-related preferences for depth, three of the groups for water velocity, and five of the groups for substrate. Stoneflies did not show any significant size-related habitat preferences.

1988/89

1. Univariate suitability curves for *Deleatidium* spp. showed that abundance was highest at about 0.4 m depth and 0.9-1.0 m/s water velocity, with a cobble substrate. Substrate alone explained 25% of the variation in abundance.

2. The best multivariate model was formed by multiplying together univariate suitability curves which had been adjusted for inter-correlation between the habitat variables. This model explained 29% of the variability in *Deleatidium* spp. abundance.

3. Addition of an index for the amount of periphyton increased the predictive ability of the model by 2%. None of the other factors considered were found to be significantly related to *Deleatidium* spp. abundance.

4. A paper presenting our findings was submitted to the *New Zealand Journal of Marine and Freshwater Research.*

1989/90

1. Preliminary comparisons of Waingawa and Clutha River data suggest that benthic invertebrates exhibit more predictable habitat preferences in rivers with more stable flow regimes. To test this theory, a decision was made to obtain data from additional rivers.

IMPLICATIONS AND RECOMMENDATIONS

Benthic invertebrate biomass has been shown to be a significant factor (together with cover, weighted usable area, and percentage scrub) in predicting trout abundance in some New Zealand rivers (see DOC transfer-funded project S7050/337 Executive Summary (Interim)). Furthermore, trout biomass is related to invertebrate community structure (J.M. Quinn pers. comm.), which in turn is influenced by substrate size, flow variability (water velocity), and the degree of catchment development (Quinn and Hickey in press). Thus, knowledge about habitat preferences of benthic invertebrate groups could perhaps be used to predict invertebrate community structure and biomass, and trout abundance. Relationships between benthic invertebrate biomass and native fish or blue duck abundance may also exist.

Appropriate suitability functions are essential to the proper implementation of the IFIM (Gore and Nestler 1988). The genus *Deleatidium* is widespread and abundant throughout New Zealand rivers. Its dominance of many stream faunas and its value as fish food make it an important target species to consider in the IFIM.

Though only about 25% of the variability in *Deleatidium* spp. abundance was explained by substrate, water velocity, and depth, this is similar to results obtained overseas for other species (Orth and Maughan 1983, Morin *et al.* 1986). If velocity, substrate, and depth are the only flow-related factors controlling abundance, IFIM can evaluate habitat suitability and can be used to make qualitative estimates of the effect of flow changes on *Deleatidium* spp. abundance in situations where the flow regime is not severely modified.

Because data from only one river, the Waingawa, were used in this study, the habitat preferences and suitability-of-use functions described here require validation. Similar hydraulic and invertebrate information is available from DSIR for three rivers, the Clutha, Mohaka, and Mangles. We recommend that these data be used to test our findings.

REFERENCES

Bovee, K.D. 1982: A quide to stream habitat analysis using the instream flow incremental methodology. *United States Fish and Wildlife Service Cooperative Instream Flow Group, Instream Flow Information Paper 12.* 248 p.

Burnet, A.M. 1969: A study of the inter-relation between eels and trout, the invertebrate fauna and the feeding habits of the fish. *N.Z Marine Department, Fisheries Technical Report No. 36.* 23 p.

Collier, K.J., and Winterbourn M.J. 1987: Faunal and chemical dynamics of some acid and alkaline New Zealand streams. *Freshwater Biology 18:* 227-240.

Gore, J.A., and Nestler, J.M. 1988: Instream flow studies in perspective. *Regulated Rivers: Research and Management 2:* 93-101.

Jowett, I.G. 1982: The incremental approach to studying stream flows: New Zealand case studies. pp. 9-15. *In*: McColl, R.H.S. (ed.), River low flows: conflicts of water use. *Water and Soil Miscellaneous Publication No. 47.*

Jowett, I.G., and Richardson, J. 1990: Microhabitat preferences of benthic invertebrates in a New Zealand river and the development of in-stream flow-habitat models for *Deleatidium* spp. *N.Z. Journal of Marine and Freshwater Research 24:* 19-30.

Morin, A., Harper, P-P., and Peters, R.H. 1986: Microhabitat-preference curves of blackfly larvae (Diptera: Simuliidae): A comparison of three estimation methods. *Canadian Journal of Fisheries and Aquatic Sciences 43:* 1235-1241.

Mosley, M.P., and Jowett, I.G. 1985: Fish habitat analysis using river flow simulation. *N.Z. Journal of Marine and Freshwater Research 19:* 293-309.

Orth, D.J., and Maughan, O.E. 1983: Microhabitat preferences of benthic fauna in a woodland stream. *Hydrobiologia 106:* 157-168.

Quinn, J.M., and Hickey, C.W. (in press): Characterisation and classification of benthic invertebrates in runs in 88 New Zealand rivers in relation to environmental factors. *N.Z. Journal of Marine and Freshwater Research.*

Sagar, P.M., and Eldon, G.A. 1983: Food and feeding of small fish in the Rakaia River, New Zealand. *N.Z. Journal of Marine and Freshwater Research 17:* 213-226.

Towns, D.R. 1979: Composition and zonation of benthic invertebrate communities in a New Zealand kauri forest stream. *Freshwater Biology 9:* 251-262.