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Land-use influences on New Zealand stream communities: effects on species composition, functional organisation, and food-web structure

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Abstract We used standardised techniques to assemble 18 food-webs in streams subject to four land uses; exotic pasture, native tussock, native forest, and pine plantation. There were clear differences in the algal productivity and standing crops of organic matter between the forested (native and pine) and grassland (tussock and pasture), but not within each grouping. Algal productivity was more than twice as high in the grassland sites, whereas the converse was true for organic matter standing crop. These differences in energy resources were correlated with differences in community composition and food-web structure. Although all streams had a generalist core of species, certain species of algae and invertebrates were predictably associated with either forested or grassland sites. Food-web structure in the forested and grassland sites was also distinct. Grassland food-webs were complex, highly internally connected, and typified by a "triangular" shape. Forested food-webs in contrast were less highly connected, tended to have fewer trophic levels, and were "squarer" in shape. These results provide some support for the concept that energy supply may be an important contributing factor influencing stream community structure. In terms of riparian management, the results emphasise the importance of protecting representative vegetation around streams to protect stream communities.

Keywords land-use; stream; food-web structure; productivity

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INTRODUCTION

A growing awareness of the importance of the lateral linkages between streams and their riparian margins has been a characteristic of studies in stream ecology in the last two decades. Land-use effects have been suggested to have profound influences on stream food-webs at both local and landscape spatial scales (Woodward & Hildrew 2002). A variety of studies have shown that riparian land use has a pervasive effect on stream hydrology (e.g., Fahey & Jackson 1997), geomorphology (e.g., Leeks 1992; Davies Colley 1997), water chemistry (e.g., Hildrew & Ormerod 1995; Friberg et al. 1997), and supply of allocthonous materials (e.g., Edwards & Huryn 1995). All of these effects have important consequences for the biological communities that occur within streams. It is therefore not surprising that a wealth of studies have described differences in the taxonomic composition of invertebrate communities in streams with different riparian land uses. Hopkins (1976) observed lower invertebrate production in a forested compared with unshaded stream reach in the Tararua Ranges. More recent studies have shown the influence of riparian land use on invertebrate community structure (e.g., Harding & Winterbourn 1995; Quinn et al. 1997; Townsend et al. 1997a; see Quinn 2000 for a review). Pasture streams have been shown to have higher invertebrate densities, and a number of taxa have been associated with pastoral settings (Quinn 2000).

Although a number of studies have described differences in the taxonomic composition of invertebrate communities in streams with different riparian land uses, few have explored the implications that this has for the functional organisation and community structure of the streams. Differences