

INTRODUCTION / INTRODUCTION

Progress towards understanding the structure, function, and ecological significance of small stream channels and their riparian zones

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Abstract: Incomplete knowledge of the ecological functions of small streams and their riparian zones, particularly their roles in larger watershed and landscape contexts, contributes to confusion and debate about the levels of riparian vegetation retention required along small streams for the purpose of protecting aquatic ecosystems, riparian wildlife, and water quality. As a consequence, there are marked differences in riparian forestry practices and management among jurisdictions throughout North America. To aid in resolving these issues, a symposium on small streams and their riparian zones was held at The University of British Columbia from 19 to 21 February 2002, which brought together scientists, managers, and practitioners and provided a forum for the presentation and discussion of emerging research results. This special issue includes a selection of papers presented at that symposium as well as one solicited paper.

Résumé : Une connaissance insuffisante des fonctions écologiques des petits cours d'eau et de leurs zones riveraines, particulièrement à l'échelle plus vaste du bassin versant et du paysage, alimente la confusion et les discussions concernant le degré de rétention de la végétation qui est nécessaire le long des petits cours d'eau, pour la protection des écosystèmes aquatiques, de la faune riveraine et de la qualité de l'eau. Il y a par conséquent des différences marquées dans l'aménagement et les pratiques forestières en zone riveraine entre les différentes juridictions partout en Amérique du Nord. Dans le but de contribuer à résoudre ce problème, un symposium traitant des petits cours d'eau et leurs zones riveraines a été organisé à The University of British Columbia du 19 au 21 février 2002. Ce symposium a rassemblé des chercheurs, des gestionnaires et des praticiens et a permis de présenter et de discuter les résultats des travaux de recherches les plus récents. Cette section spéciale inclut un choix d'articles présentés lors de ce symposium ainsi qu'un article sollicité.

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In recent years, there has been growing concern about riparian management practices around small streams, particularly in the context of forest harvesting. One problem in managing small streams and in applying research results to practical problems is that there is no clear definition or consensus of what constitutes a small stream. The term is often used interchangeably with "headwater" streams, which include the most headward channels within a channel network, and which are typically bordered by hillslopes and zero-order basins. Small streams may or may not be headwater streams, but both are subject to similar management con-

cerns, as they are often afforded a low level of riparian protection in forest management.

Small streams have been neglected by researchers relative to the attention paid to larger, downstream reaches for many reasons, but not for lack of importance. Small streams typically constitute most of the total channel length within a watershed in humid areas (e.g., Shreve 1969). Unfortunately, upwards of 75% of perennially flowing small streams do not appear on topographic or forest cover maps (Meyer and Wallace 2001). Inaccurate mapping of small streams is especially a problem in forested landscapes, as the smallest of streams often have complete canopy cover and cannot be detected by remote sensing or on aerial photographs.

Small streams should figure more prominently in our studies of stream networks for several reasons. Small stream channels and their riparian zones provide unique habitats for some organisms, some of which may be found nowhere else in the stream network (Meyer and Wallace 2001). Because of the close coupling between terrestrial and aquatic systems around small streams, small channels can be important sources of sediments, water, and nutrients to downstream systems (e.g., Gomi et al. 2002). In the Pacific Northwest, small channels are often steep and the source of channelized

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debris flows. They also store and slowly release organic matter, potentially providing for high rates of detrital-based productivity and transport to downstream fish streams (Wipfli and Gregovich 2002). The hydrologic, geomorphic, and biological processes that characterize small streams differ in their rates, and in some cases qualitatively, from downstream reaches. In particular, downstream changes in availability of food and habitat, as well as patterns of stream and riparian disturbances, can affect food web structures and ecological functioning along channel networks (Power and Dietrich 2002).

The management context for concern around small streams includes the usual motivation of fisheries biologists, that these channels can provide habitat during high flow periods when juvenile salmonid and residential fishes move up into less hydraulically active channels (Rosenfeld et al. 2000). There is also concern for the consequences for supply and services from these streams, mostly in terms of organic matter storage and transport (Webster et al. 1999), and supplies of energy sources (e.g., drifting invertebrates) to fish in downstream reaches (Wipfli and Gregovich 2002). Because stream ecologists and managers have dominantly focused on fish-bearing streams, research on small streams has not kept pace with our understanding of process domains in larger, fish-bearing reaches of the stream network.

Incomplete knowledge of the ecological functions of small streams and riparian zones, particularly their roles in larger watershed and landscape contexts, contributes to confusion and debate about the levels of riparian vegetation retention required along small streams for the purpose of protecting aquatic ecosystems, riparian wildlife, and water quality. Government agencies have struggled with how to define and classify small streams and to specify the kinds of protection they should be afforded. As a consequence, there are marked differences in riparian forestry practices and management among jurisdictions throughout North America, and even within the Pacific Northwest, where one should expect some level of congruence given the commonalities in governing conditions (Young 2000; Blinn and Kilgore 2001).

As a first step toward resolving these debates, a group of scientists concerned with small stream studies organized a symposium entitled *Small Stream Channels and their Riparian Zones: Their Form, Function and Ecological Importance in a Watershed Context*. The symposium was held at The University of British Columbia, 19–21 February 2002, and was sponsored by the following organizations and agencies: Forest Renewal British Columbia, British Columbia Ministry of Forests, British Columbia Ministry of Sustainable Resource Management, United States Forest Service, Department of Fisheries and Oceans Canada, and The University of British Columbia. Over 300 people attended from as far away as Australia and Japan, including practitioners from a variety of agencies and nongovernmental organisations, as well as scientists from academic and government institutions. This symposium provided a forum for the presentation and discussion of cutting-edge scientific research covering hydrology, geomorphology, and aquatic and terrestrial ecology, as they relate to small streams and their riparian zones. This special issue includes a selection of papers presented at the symposium as well as one solicited paper (Reeves et al. 2003), all primarily based on research conducted in the Pa-

cific Northwest. None of the papers included in this issue deal with fish, reflecting the frequent absence of fish from small, steep streams in temperate North America.

Although previous research has documented the important role of woody debris in larger stream channels (e.g., Murphy and Koski 1989; Hyatt and Naiman 2001; Benda et al. 2002), it has been less well studied in the more headward portions of the stream network (a notable exception is Gomi et al. 2001). The papers by May and Gresswell (2003) and Reeves et al. (2003) provide new perspectives on woody debris dynamics in headwater streams. In particular, May and Gresswell (2003) investigate the recruitment of woody debris in steep headwater channels, while Reeves et al. (2003) demonstrate linkages between tributaries and main stream systems with respect to woody debris transport. Woody debris appears to play a more prominent role in some small, steep streams than formerly appreciated, perhaps dependent on history of mass movements as well as the size of bed materials otherwise available to structure local channel morphology.

Much of our knowledge of small streams has come from studies in rain-dominated coastal catchments, notably the paired-catchment studies conducted in the Oregon Coast Range and Cascades, Carnation Creek in British Columbia, and the Caspar Creek study in California. The Stuart–Takla Fisheries/Forestry Interaction Project, a multiagency project initiated in the early 1990s, had the objective of increasing our knowledge of fish–forestry interactions and small watershed processes in the sub-boreal, snowmelt-dominated environment of the central interior of British Columbia. Four papers in this special issue present results from portions of the Stuart–Takla project, extending our appreciation of small streams beyond coastal regions. All four examine effects of forest practices on stream processes. Three are focused on physical responses (temperature, streamflow, suspended sediment) to forest management (Story et al. 2003; Macdonald et al. 2003a, 2003b), while Fuchs et al. (2003) present results of some of the first research focused on the biology of nonfish organisms in small streams in that region.

Detailed research on the biology of small streams and their riparian zones in western North America has been limited to date. In addition to the paper by Fuchs et al. (2003), this special issue includes four studies of elements of the biological community. Cole et al. (2003), Price et al. (2003), and Sheridan and Olson (2003) present studies dealing with benthos and amphibians, while the paper by Kreutzweiser and Capell (2003) focuses on the role of dissolved organic matter in supporting the metabolic processes of headward channels.

This special issue of the *Canadian Journal of Forest Research* highlights the expanding appreciation of the critical role of small streams and their riparian zones in broader landscape and watershed contexts. It will provide an introduction to the many facets of our growing knowledge and the difficult management context within which debate about conservation exists.

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