The Importance of Small Streams in British Columbia

FREP

Extension Note #38

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INTRODUCTION

What is a "small stream"? This article provides the Ministry of Forests, Lands and Natural Resource Operations' definition and explains their importance. It is the first of three extension notes that are specific to small streams. This series is prompted by monitoring results obtained from the Province of British Columbia's Forest and Range Evaluation Program (FREP), indicating that many small streams have been left in poorly functioning condition (Tschaplinski 2010, 2011). The second note in this series will summarize the condition of small streams in British Columbia, using FREP data collected from 2006 to 2015, and describe the causes of impacts that affected the condition ranking. The third, to be released after feedback and collaboration with forest licensees, will identify methods and opportunities to avoid and mitigate impacts to small streams and, subsequently, to downstream reaches. These extension notes are intended for resource professionals and managers interested in riparian areas and the influence that small streams have on overall watershed condition. The overall goal is to promote further discussion and research on successful harvest strategies around small streams, and to ultimately reach agreement on effective and feasible forest harvest standards that will protect this important resource.

Small streams and the plant communities alongside them are valuable ecosystems because they often support a diversity of vegetation, invertebrates, and vertebrates not found in other areas of a watershed (Meyer et al. 2007). Along with supporting unique assemblages of plant and animal species, small streams have been shown to contain necessary habitat for juvenile fish (Rosenfeld et al. 2002). Whether they contain fish or not, all small streams contribute water, sediments, nutrients, and vegetative matter to downstream fish-bearing reaches (Chamberlin et al.1991; Wipfli and Gregovich 2002; MacDonald and Coe 2007). These contributions are increasingly being recognized as the key drivers of overall watershed condition and function (Gomi et al. 2002; Richardson and Danehy 2007; Wipfli et al. 2007; Wipfli and Richardson 2016).

Changes to small streams that result from harvest activities close to a stream edge are well documented (e.g., Bisson and Bilby 1998; Richardson and Danehy 2007), and include:

- higher water temperatures (MacDonald et al. 2003a; Moore et al. 2005; Gomi et al. 2006; Rex et al. 2012);
- changes to large wood supply and in-stream volumes (Bilby and Bisson 1998; Hassan et al. 2005; Benda et al. 2015);
- increased sediments (Benda et al. 1998; Richardson and Béraud 2014);
- loss of bank vegetation, leading to lower amounts of terrestrial invertebrates and coarse particulate organic matter (Piccolo and Wipfli 2002);
- fluctuations in stream flow dynamics (MacDonald et al. 2003b); and
- changes in benthic invertebrate communities (Fuchs et al. 2003; Kiffney et al. 2003).

These changes could affect ecosystem processes beyond the harvested reach, also impairing downstream condition and function.

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To be a world leader in resource stewardship monitoring and effectiveness evaluations; communicating science-based information to enhance the knowledge of resource professionals and inform balanced decision-making and continuous improvement of British Columbia's forest and range practices, policies and legislation. *http://www.for.gov.bc.ca/hfp/frep/index.htm*

BRITISH COLUMBIA

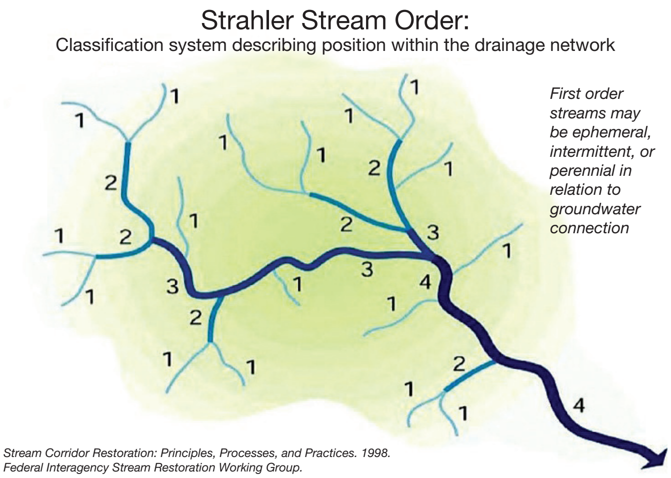
Figure 1: *Small streams located on the Coast (left) and within the Interior (right) of British Columbia.*

WHAT ARE SMALL STREAMS?

A small stream is defined here as "a channel or drainage that carries water at any time of the year, with continuous, definable banks and an average undisturbed channel width of 3 m or less" (Figure 1). We chose 3 m as the channel-width cut-off because this is the maximum undisturbed width of the smallest non-fish-bearing stream class (S6) regulated under the province's *Forest and Range Practices Act*. This stream classification scheme underlies the result categories used in FREP riparian effectiveness evaluations (Tripp et al. 2009). This definition also includes the smallest fish-bearing stream class (S4; streams < 1.5 m wide), and that portion of fish-bearing S3 streams (1.5 to ≤ 5 m wide) with channel widths of 3 m or less. On most public lands in British Columbia, S4 and S6 streams do not require fully vegetated buffers along their margins, although some ultimately do receive protection when recommended best management practices are followed, or when other objectives such as biodiversity or visual quality require retention of trees on small streams. The wider S3 streams have mandatory 20 m reserve zones in which no cutting is permitted.

Stream order is frequently used to categorize streams in a watershed and is an approximate measure of stream size that can be correlated to several other measures, including the area drained and volume of water discharged. From the hierarchy of tributaries developed by Strahler (1957), first-order streams are the smallest unbranched streams depicted on maps, regardless of scale. First-order streams become second order when two first-order streams come together, and third order when two second-order streams come together, and so on (Figure 2). A recent spatial analysis (1:20,000 scale) of all streams in the FREP data set indicated that 85% of first-order streams, and 75% of second-order streams are 3 m or less in width (n = 1728). It is also likely that many of the unmapped streams (not large enough to be identified as a waterline for Terrain Resource Information Management [TRIM] base maps) are less than 3 m. This supports the assumption that most first- and second-order streams on the provincial 1:20,000 TRIM maps are 3 m or less in width and therefore, by definition, "small."

***Figure 2:** Diagram showing stream order of a watershed.*



WHY ARE SMALL STREAMS IMPORTANT?

Small streams are important because they provide habitat to fish, amphibians, and aquatic invertebrates, and supply most of the surface water, sediments, nutrients, and organic matter to downstream reaches (MacDonald and Coe 2007; Wipfli et al. 2007). Thus, any changes in the quality, quantity, or timing of these critical components will ultimately affect fish habitat or water quality downstream (Wipfli and Richardson 2016). Although large streams frequently have their own unique catchment areas ("face" drainages) and groundwater inputs that provide other sources of water and nutrients, the contributions from these sources may be collectively small relative to that which upstream tributaries provide.

Small streams are more abundant and intimately connected to the rock, soils, and vegetation of a watershed than larger streams (Sweeney and Newbold 2014). Small streams typically account for 90–95% of the total number of streams and total stream length in a watershed, or 70–80% of the total drainage area (Gomi et al. 2002, citing Sidle et al. 2000 and Meyer and Wallace 2001). In addition, a small stream retains material that falls into it (e.g., wood, needles, and leaves) for a longer period because of its lower flows and greater number of obstacles formed by boulders, cobbles, and woody debris (Webster et al. 1999; Hoover et al. 2010). This longer residence period gives microbial, fungal, and invertebrate communities time to break down organic matter for downstream transport (Bilby and Likens 1979; Vannote et al. 1980). It also provides ample opportunity for the sediment and water interactions that facilitate mineral dissolution. Consequently, small streams contribute significantly to downstream food webs, as well as water quality, including chemistry (e.g., major ions), physical characteristics (e.g., temperature), and organic matter (e.g., litterfall and dissolved organic matter).

Terrestrial invertebrates, an additional source of nutrients in small streams, are important to fish (Wipfli 1997). Terrestrial invertebrates and other organic material transferred from small to larger streams represent a substantial subsidy of nutrients to downstream reaches. This process greatly improves production of all higher trophic levels, such as amphibians and fish (Wipfli et al. 2007). Estimates of the number of young-of the-year salmonids that could be supported by invertebrates and other food sources from small non-fish-bearing streams range from 100 to 2,000 for every kilometre of fish-bearing watercourse downstream (Wipfli and Gregovich 2002).

Depending on terrain, small streams can also play a significant role in sediment transport and storage within watersheds. A portion of the watershed sediment supply, which may include suspended sediment washed off exposed surfaces (e.g., stream banks, slides or sloughs, roads and ditch lines), starts its journey in small streams. Coarser materials (coarse sands, small gravels, and cobbles) are added when the banks of small streams and the adjacent side slopes erode. This process can result in a downstream transfer over time as sediments are released, trapped by woody debris in the smaller channels, and then gradually transported to larger downstream reaches. The flow regime, the ruggedness of the terrain, and the characteristics of the sediment will determine how far and how evenly deposition will occur. Other geomorphic processes such as mass wasting (landslides, debris flows, torrents) can episodically add very large volumes of sediment in a relatively short period.

Both small and large streams each play critical roles in supporting populations of fish and other organisms that depend on aquatic habitat. Although fish density may be greater in larger systems because of better access, year-round flow, and larger areas of complex habitat, small streams are equally important as they are the conduits for the elements needed to maintain the functioning condition of downstream reaches. Small streams and their adjacent riparian zones also support fish, amphibians, and insects at the reach level, further increasing their significance within the watershed.

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