FIA–FSP Forest Science Corner

Stemflow: A potentially important point source of water for growth

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The mountain pine beetle epidemic currently impacting British Columbia is expected to kill approximately 77% of all merchantable pine in the province by 2014. At the same time, the frequency of wildfires is projected to increase as a consequence of global climate change. Thus, in the foreseeable future, many Interior watersheds in the province will be comprised of a mosaic of young conifer forests at various stages of regrowth.

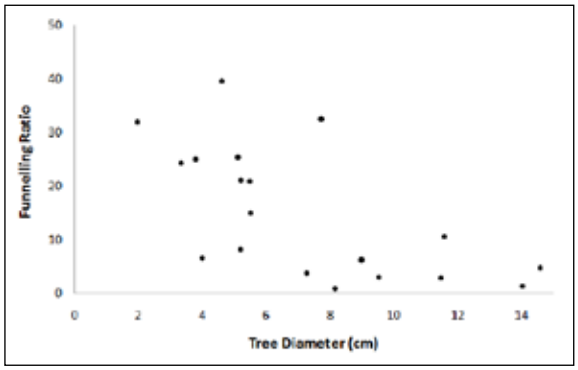

Figure 1. *Study period cumulative funnelling ratios as a function of the tree diameter (cm) of young lodgepole pine trees at Mayson Lake, British Columbia.*

This shift from a landscape dominated by mature forests to one of mostly rejuvenating stands brings with it many uncertainties, including determining the impacts on site hydrology. One aspect of site hydrology that will likely be modified is stemflow production, which is defined as precipitation that is intercepted by vegetation cover and diverted down the stem or trunk of the vegetation. Studies conducted in mature coniferous forests, including lodgepole pine (*Pinus contorta* var. *latifolia*) stands, suggest that stemflow is a minor component of the water balance of these stands. However, our research conducted at Mayson Lake in 2008, along with the few other studies conducted in juvenile coniferous forests, suggests that stemflow in these environments may be a more important water balance component.

The ability of a tree to produce stemflow can be described using the stemflow-funnelling ratio. This is the ratio between stemflow volume collected at the base of the tree's trunk to the volume that would have been collected by a rain gauge having a diameter equal to that of the tree's trunk in the absence of vegetation cover. It is calculated as:

$$F = \frac{SF}{P_G \cdot BA}$$

where F is the funnelling ration (dimensionless), SF is stemflow volume (litres), PG is rainfall depth (mm), and BA is the basal area of the tree bole (m^2).

The stemflow-funnelling ratio is an effective tool to assess how efficient a tree is at funnelling water to its base. Because certain trees have the ability to concentrate large volumes of water at their bases, stemflow in certain forested landscapes is helpful because it:

- is an important groundwater recharge mechanism;
- can contribute to the quick response of storm hydrographs; and
- can be a source of nutrients that create so-called "fertile islands" in the soil that surrounds trees.

Funnelling-ratio research has been conducted in temperate deciduous and tropical rainforests, as well as on certain shrub species, but not in coniferous forests. We believed that if we could show that the magnitude of F values in coniferous forests, such as juvenile lodgepole pine stands, is appreciable then further research into the importance of stemflow as a hydrologic process and as an important point source of water for regulating tree growth could be warranted.

During the summer of 2008, a complete stemflow record was measured from 19 healthy lodgepole pine trees selected from four research plots at the Mayson Lake Hydrological Processes Study Area, located approximately 60 km NNW of Kamloops, BC on the Thompson–Bonaparte Plateau at 51°13' N, 120° 24' W. Tree diameters averaged 7.3 cm and ranged from 2.0 to 14.6 cm. A total of 13 stemflow-producing rainfall events totalling 52.3 mm and ranging in depth from 0.7 to 8.6 mm were recorded between June 1 and September 30. The average cumulative F value for the 19 trees was 14.9, ranging from 0.8 for an 8.2-cm diameter tree to 39.6 for a 4.6-diameter tree. Study period F values were negatively correlated with tree diameters, with the efficiency of trees diverting intercepted rainfall to their bases declining greatly once

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More information on stemflow project

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Further stemflow work planned for 2010

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diameters exceeded 8 cm (Figure 1). For the largest rainfall of the study period, 8.6 mm, the average F value was 28.4, with a maximum of 79.7 for the 4.6-diameter tree. An F value of 79.7 for this one 8.6-mm event suggests that stemflow at the base of the tree had an equivalent depth of 685 mm, greater than the average precipitation depth for the entire year in this region.

The F values calculated at Mayson Lake suggest that stemflow is an important point source of water for potential use by juvenile lodgepole pine, especially for those having diameters of less than 8 cm. We will conduct further work during the 2010 growing season to determine the influence that other tree characteristics, such as branching angle, number of branches, and crown diameter, as well as meteorological factors, such as rainfall intensity and wind speed, have on stemflow production and thus, F values. In addition, we will investigate the influence of stemflow on soil moisture and temperature at the base of juvenile trees to determine the potential importance of this point-water input on stand productivity.