Riparian management and stream temperature

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INTRODUCTION

The scientific literature clearly shows that the summertime temperature of a stream in a temperate forested environment tends to increase after removal of riparian vegetation. In general, temperature increases are not a function of the amount of harvesting in a watershed, but rather are a function of the reduced level of shade provided by riparian vegetation. Both mathematical models and empirical observations indicate that temperature increases may be prevented as long as effective riparian buffers preserve stream shading. Effective buffers are those that maintain stream shading at close to natural levels, and that resist blowdown.

RIPARIAN BUFFERS

Riparian buffers are clearly capable of preventing alterations in stream temperature regimes. However, specifying riparian buffers in practice requires the weighing of costs and benefits in the absence of complete information. Returns diminish when buffers are wider than some optimum width or are further upstream from the target reach than some optimum distance. The uncertainty surrounding the ideal specifications for riparian buffers is partly encompassed by the questions "how wide" and "how far upstream."

Buffer width itself is only an indirect criterion for preserving shade. A fixed-width buffer on both sides of a stream is a simple specification, but the amount of shade this provides varies with factors such as stream orientation, topography, and the characteristics of native vegetation. When a stream has an east–west orientation, trees on the north side provide only a limited amount of shade at midday, and only if their branches overhang the water. Therefore, fixed-width buffers are not as efficient at minimizing stream temperature as are buffers designed to maximize the retention of shade. It is, therefore, more effective to think of "buffer design" than "buffer width."

MEASURING STREAM SHADE

Various methods are used to estimate the amount of shade provided to a stream by riparian vegetation. The most logical measurement recommended in the literature is of *angular canopy density.* This parameter is defined as the percent canopy along that portion of the sun's path between 10:00 A.M. and 2:00 P.M. (local solar time) in mid- to late summer as viewed from the water surface. Perhaps a simpler

Citation —

Teti, P. 2000. Riparian management and stream temperature. *In* Proceedings, From science to management and back: a science forum for southern interior ecosystems of British Columbia. C. Hollstedt, K. Sutherland, and T. Innes (editors). Southern Interior Forest Extension and Research Partnership, Kamloops, B.C., pp. 27–8.

definition is the "shade during the 4 hours at midday." This measurement is not yet in general use. Instead, shade is approximated by methods of unknown accuracy. Obviously, shade is highly variable along a stream's width and length, and any sampling procedure must consider this.

Methods are being developed to measure stream shade as angular canopy density at a point and to sample shade along a stream reach.

DOWNSTREAM EFFECTS

One of the most important findings in the literature is that the downstream thermal effects of harvesting on small, non-fish bearing streams may be small. Research in Washington State has shown that the cumulative temperature effects on third-order streams attributed to the harvesting-related heating of first- and second-order streams are minimal.

THERMAL RECOVERY

The increase in shade with revegetation becomes increasingly important as watersheds and steam channel networks accumulate a longer management history. The time required for "thermal recovery" after logging in riparian areas depends on factors such as stream width, stream azimuth, and local topography, as well as factors that affect riparian species composition and their rates of growth. Two studies conducted on the pacific coast indicated that increases in stream temperatures after logging lasted 3–7 years. No studies were found of temperature recovery in the Interior. However, other studies document increases in stream shade after logging. Shade recovery may take up to 20 years at higher elevations in the Oregon Cascades. Incorporating thermal recovery into the long-term management of stream temperature could be based on empirical relationships between stream shade and time since logging, grouped according to geographic variables.

CONCLUSION

A literature review on the effects of riparian management on stream temperature can be downloaded at www.for.gov.bc.ca/cariboo/research/hydro. The Ministry of Forests is identifying additional needs for stream temperature research and is developing management tools.

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